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POWER

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Making a Race

THINGS happen and are little regarded, but they have a profound effect upon the habits, the progress and condition of the race.

We might instance the development of language spoken and written, the use of a system of numerals leading to all the usefulness and achievements of mathematics, but let us think back only to the invention of printing.

Not so long ago; less than five hundred years to its beginnings and a good deal less than that since its popularization and the universality of its benefits.

It would take more than my short page to paint the condition of the people, the handicap of even the intellectuals without it. Visualize it yourself by reviewing to what extent you are indebted for your knowledge of affairs, for your mental resources, for your attitude toward life, to the printed page from the morning paper beside your plate to the evening chapter.

An effect no less profound was wrought upon the habits of the people by the development of the automobile. In its enlargement of the radius of the ordinary life, the promotion of travel and intercourse, the broadening of the mental as well as of the physical environment, it has speeded up the race in more ways than the speedometer will show.

And now we are being subjected to the influence of two other developments the effect of which is bound to be prodigious.

You buy a paper for a few cents or a book for a few dollars and you have only commenced. To build their contents into your system and make them a part of your mentality requires application, reading, concentration, time, thinking.

The radio feeds it to you with a compelling insistence. One hardly has to listen to be the recipient of all sorts of information, inspiration and suggestion while busy about his ordinary comforts or chores.

And the movie, with its growing possibilities of attracting and holding interest and instilling wisdom or propaganda. The effect of these two upon the thinking and the conduct of the race will be stupendous.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Two More Appreciations of Fred R. Low

IN MAKING up the three pages of letters from some of Mr. Low's friends in the field, which appeared in last week's issue, two letters were left out through an unfortunate oversight. These are reproduced below:

LETTER FROM A. C. FLORY

I understand that October marks Mr. Low's forty years of Editorship. During this period he has seen, assisted in and visualized the growth and development of a tremendous industry. The service he has rendered should be a real satisfaction to him. I do not know of a man who has as large an acquaintanceship in the power industry or as many friends.

In spite of the tremendous amount of work he has done for the industry, and to make *Power* an outstanding publication, he has found it possible to give time and his mature judgment to other important activities.

It is a privilege to express my appreciation of this opportunity to congratulate *Power* and to wish Mr. Low health and happiness.

A. C. FLORY, *Manager, Steam Turbine Department, Allis-Chalmers Manufacturing Company.*

LETTER FROM F. M. FEIKER

During my student days at the Worcester Polytechnic Institute and for ten years after, I knew Fred Low, the Editor, by name only. But his vigorous editorials on the problems of the power producer and power user gave me a very definite impression that there was a personality behind the pen.

In that unforeseen way in which our destinies are guided, during the next ten years or more, I became closely associated with him as a fellow-editor in the McGraw-Hill organization. In this association I came to admire not only the independence of thought, but the sweetness of character, which make up Fred Low, the man.

Fred Low represents a type of personal journalism which has practically disappeared from the newspaper and general magazine field. Industrial journalism relies on personal leadership and intimate personal knowledge of the field of the publication. In many ways the business press represents the best of journalistic thinking and acting in the present day.

A celebration of Fred Low's fortieth anniversary as editor of *Power*, therefore, not only marks the successful life work of a leader of his profession, but a call to action to hundreds of younger editors in the business press upon whom rests the burden of clear thinking, independent reasoning, courageous expression and colorful writing.

F. M. FEIKER, *Managing Director, The Associated Business Papers, Inc.*

Organizing Safety

PERHAPS no other slogan has won such universal use as "Safety First." Brought into being years ago as an expression of humanitarian instinct and sound business thinking, it became a powerful force in American industry. This great ideal was dimmed for a time by the passing shadow of the War, but later revived as a force more powerful than ever. Today safety is more than an ideal. It is a profession in itself, with hundreds of full-time practitioners, tens of thousands who devote part of their time to accident prevention and millions who profit by its services.

And so it is fitting that each year should see a great convention devoted entirely to the subject of safety. Those who attended the Seventeenth Annual Safety Congress in New York last week saw what man power and organization can accomplish. Back of this Congress stood the 4,600 members of the National Safety Council and a staff of 83 employees who devote all their time to its activities. The results of intensive effort were evident in the Congress. Industry was covered with astonishing completeness in the numerous sessions and more numerous papers. This thought and activity will surely have its effect in the field.

The great safety movement deserves the active support of every citizen and, in particular, of every engineer. For the engineer stands as the man in industry best fitted to translate into fact the ideals of good management and sound humanitarianism.

Truth in Advertising

A TRADE practice conference of magazine publishers has been called by the Federal Trade Commision for the purpose of formulating simple, workable standard rules intended to eliminate from this field of publicity all advertising of a false or misleading nature. This co-operation by the government in helping to bring about a general acceptance of the advertising standards long established in the better-grade papers, is greatly to be commended.

In almost every industry there can be found black sheep whose methods of operation are considered unethical by the rest of the trade. It is the regulation of these, by rules agreed upon by a majority of the concerns involved and enforced by the Trade Commission, that has helped to elevate industry to its present high ideals.

Power has always been among the leaders in maintaining an advertising service kept as free from false and misleading statements as is humanly possible. This move of the Federal Trade Commission is a welcome one.

Standing in the Way of Progress

UNCLE Billy Palmer stood out in town meeting against the bond issue for sewer construction. His father and his grandfather before him had lived their lives without there being any sewer in the village. As long as he could prevent, Uncle Billy was resolved that no such new-fangled, wasteful improvements should serve to increase taxes. And so he successfully stood in the way of progress until he passed to the great beyond, after which the town went ahead and modernized.

Unfortunately, the Uncle Billies of this life are not confined to civic affairs. Too many industrial plants, even in this day of progressiveness and rapid engineering advance, have someone in their organization who is unnecessarily conservative about changes.

A human sea-anchor of this type is greatly needed in some endeavors, as a counterbalance against ill-considered innovation. But in any activity as closely under the control of engineers as the generation and use of power, this braking action is superfluous. For engineers themselves are apt to be over-conservative. They need no assistance in holding back from the new.

In fact, at times engineers have played the rôle of Uncle Billy, standing in the way of progress. None would recommend that engineers accept the new thing merely for the sake of change. But when a new operating method or equipment design shows reasonable promise of being successful, its adoption should be considered. Engineers who do not follow this course will fail to realize the profits obtained by their more progressive fellows.

Less Waste in Transmission and Application

POWER transmission in industrial plants generally begins at the busbars in the generating station or at the service entrance. It is at this point that effort should start to reduce waste in power transmission. Not infrequently, considerable expense is incurred to improve the efficiency of the generating plant, only to allow several times this saving to be lost in transmission and application. These losses are caused by using too small conductors, motors improperly lined up with their loads, tight belts, shafting out of line, improper application of motors and power-transmission equipment and many other causes.

A little attention given to the layout and selection of equipment will reduce many of these losses at small expense. Conductors too small for a feeder are selected when large ones could be had at small increase in cost. Figures made on a conduit system showed that wire two sizes larger than was used could have been pulled into a conduit, so that the only expense involved for increasing the size of the feeder would be for copper. In this case the saving in power by using the larger conductors would have paid a return of about sixty per cent on the additional investment in copper. Such opportunities are frequently ignored as if money put into copper were lost.

Selection of motors for special applications is fraught with many pitfalls for the unwary. If motors are too large, the investment is high and the efficiency lower than it should be, with resultant higher operating charges. On the other hand, motors too small are worse than those too large because of the excessive maintenance costs and lost production due to shutdowns.

Some engineers seem to be imbued with the idea that direct connection of motors is the only good practice. Such a policy leads to the selection of large, expensive, slow-speed motors where high-speed motors with suitable speed reducers could be used at much less expense, and a higher efficiency in the applications obtained. Where induction-type alternating-current motors are used, slow-speed motors are to be avoided, on account of their lower efficiency and power factor, both of which increase the cost of power.

Where adjustable speed is required, particularly with alternating current, there may be a number of solutions of the problem as indicated in the leading article in this issue. A simple squirrel-cage motor with a mechanical-type variable-speed transmission will frequently prove the most economical. In other applications it may be more economical to convert alternating current into direct and use direct-current motors.

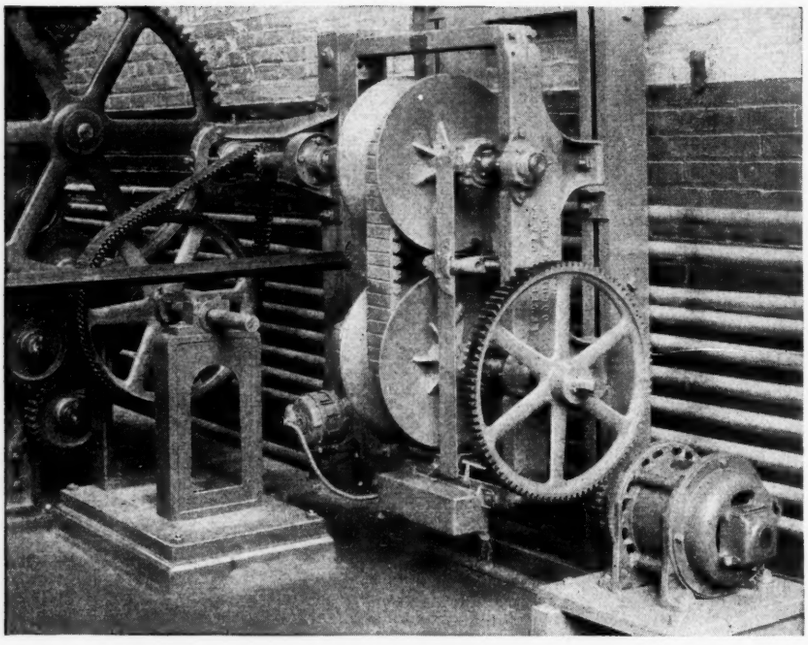
No matter how the problem of power transmission and application is solved, the measure of its effectiveness is the cost and quality of the finished product. Whichever system will give the lowest over-all cost for a given quality is the most economical. This is the criterion of good engineering.

The Neon Tube as a Safety Sign

SINCE its invention the Neon lamp has been applied to many and varied uses, one of which is as a safety sign on high-voltage conductors. Formed to spell the word *danger,* the tube glows when the conductor is energized and is out when the conductor is dead.

This idea seems attractive, but there is danger that all hands will come to consider the conductor as unsafe when the tube is glowing, and by the same reasoning that it is safe to approach when the lamp is out. This procedure may lead to a serious accident due to a defective tube indicating a dead conductor when the line is actually energized.

A high-voltage conductor should not be considered safe just because some kind of device indicates the line to be dead. It is far safer to wait until the line has been blocked out of service, tested and grounded before considering it safe to work on. The use of any device that tends to interfere with this practice should be discouraged. However, the Neon tube used as a portable testing indicator may serve to prevent the grounding of a live conductor, and for this purpose it is a desirable addition to the power plant's stock of electrical instruments.



Lewellyn vertical variable-speed transmission installed in a worsted mill

ADJUSTABLE SPEED

Obtained with Alternating-Current Motors

By F. A. Annett
Associate Editor, Power

ALTERNATING-CURRENT motors of the synchronous and induction types are inherently constant-speed machines. The speed of the synchronous type is fixed by the relation between the line frequency and the number of poles in the machine. This is also practically true of the squirrel-cage induction type, although it may be slowed down by connecting a resistance in series with the stator winding. This method is very limited in its application and, to be satisfactory, must be used with a constant load on the machine. If the load is variable, at light loads the motor will operate at nearly full speed and at heavy loads it will slow down and may stall.

The torque of a squirrel-cage motor varies as the square of the voltage applied to the stator winding. For this reason, if the voltage is reduced by one-half, the torque of the motor will be reduced to one-quarter of the full-voltage value. This rapid change in the torque makes the operation of the motor unstable if any attempt is made to reduce the speed below about 75 per cent normal, with a stator resistance. Where adjustable speed is required and a single-speed induction motor is used to drive the machine, the only satisfactory way it can be obtained is by some form of mechanical variable-speed transmission.

Wound-rotor induction motors have an insulated winding on the rotor the same as in the stator. The rotor winding connects to slip rings and to an adjustable external resistance for starting. If this resistance is designed for continuous operation, connecting it in series with the rotor, the speed of the motor can be decreased if the load is fairly constant. With variable loads the speed changes inversely as the load, which for most applications would be unsatisfactory.

The limit of speed change by this method is only about two to one. That is, if the full speed of the motor is 1,800 r.p.m., by rotor-resistance control it can be slowed down to about 900 r.p.m. If slowed down below one-half normal, the operation of the motor is likely to be unstable.

If this method is used to change the speed of a constant-torque load, the efficiency of the motor at reduced speed will be low. The motor at one half-speed will take the same current as at full load, but will develop only one-half the horsepower. The other half of the power is lost in the resistance connected in series with the rotor. Under these conditions the efficiency decreases almost directly as the speed. If the efficiency is 90 per cent at full speed and load, at one-half speed the efficiency will be around 50 per cent.

Assume that the motor at full speed and full load takes ten kilowatts. At half-speed the motor will take practically the same power from the line, but about five kilowatts will be lost as heat in the external resistance. If the motor were to operate this way four hours a day for 300 days in the year, the kilowatt-hours lost in the rheostat would be $5 \times 4 \times 300 = 6{,}000$. At two cents per kilowatt-hour the power would cost $6{,}000 \times 0.02 =$ $120.

Using a constant-speed motor with a variable-speed transmission would save a large part of this power. This saving in about three years would pay for a transmission, which would have an efficiency of about 87 per cent at mean speed. When using a variable-speed transmission, a squirrel-cage motor in most cases can be applied and can be started by connecting it directly across the line. In this case the only starting equipment necessary would be a line switch of simple design.

With the wound-rotor motor and external-resistance speed control, the cost of the motor and the control equipment will be about double that of the squirrel-cage motor with the across-the-line switch. With a variable-speed transmission the speed change is not limited to two to one, but may be obtained to give any desired range up to sixteen to one. When using a wound-rotor motor, the speed changes are limited to the number of points on the controller, whereas the variable-speed transmission will give an infinite number of speed adjustments.

A drive for a fan presents an entirely different problem from that for a constant-torque load. The power to drive a fan varies approximately as the cube of the speed, consequently the load decreases rapidly with a decrease in speed. Where the losses in the external resistance of the rotor, at 50 per cent speed and a constant-torque load, are 50 per cent of the input at full speed, for a fan they are only about 18 per cent. With a constant-torque load there is no decrease in the power input for a speed reduction. Decreasing the speed of a fan causes a power decrease. At 50 per cent speed the power input is only about 37 per cent of that taken at full speed. For this reason, if the speed reduction required does not exceed 50 per cent, it may be found economical to use a wound-rotor motor with external-resistance speed control for fan drives. For ventilation purposes this type of drive will generally meet the requirements.

Many industrial processes require wide ranges of speed adjustment in their drives. Different methods of providing varying-speed drives when alternating current only is available are described, and variable-speed mechanical transmissions with constant-speed motors are compared with methods of changing the speed of the driving motor.

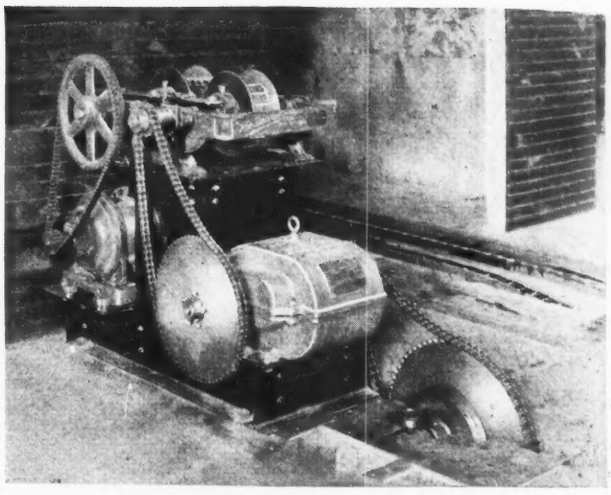


Fig. 2—Reeves variable-speed transmission installed on a body-paint conveyor in an automobile plant

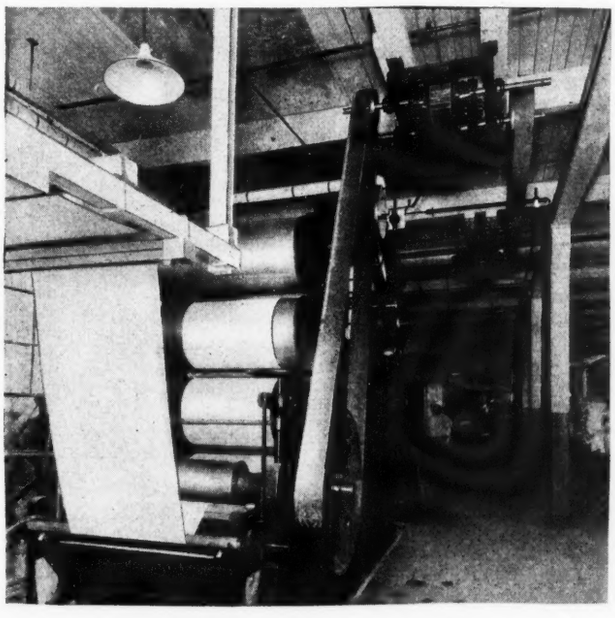


Fig. 1—Variable-speed transmission mounted on the ceiling operating a drier in a textile finishing mill

Where speed ranges greater than two to one are required, sometimes two-speed motors with a wound rotor are used. For instance, a 60-cycle motor's winding could be connected six-pole for operation at about 1,150 r.p.m., and connected twelve-pole for 575 r.p.m speed. With six-pole operation, by connecting resistance in series with the rotor, the speed can be decreased to about 575 r.p.m., the speed obtained by the twelve-pole winding. Then, by switching over to the twelve-pole winding and again connecting the resistance into the rotor circuit, the speed can be reduced to about 300 r.p.m. By such an arrangement a speed range can be obtained of four to one, in steps depending upon the number of contact points provided in the controller. Ten points on the controller will give twenty different speed steps between 300 and 1,150 r.p.m. Such motors are used for fan, pump and other applications.

These machines have the advantage of being a compact units, but have the disadvantage of low efficiency when operating on reduced speed with the rotor resistance in circuit. They are expensive to construct and

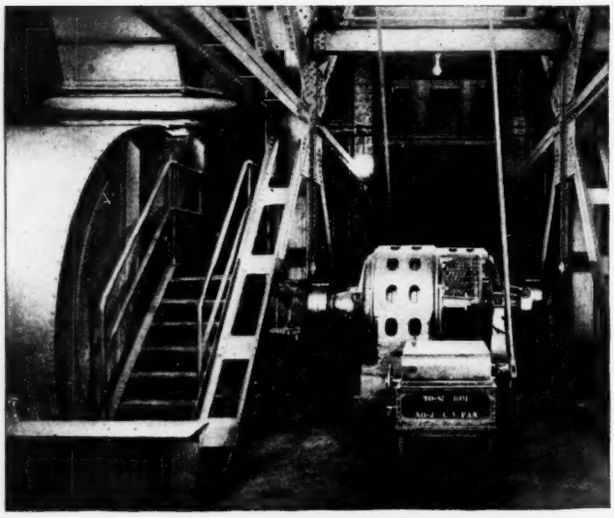


Fig. 3—Polyphase commutator-type varying-speed motor driving an induced-draft fan

require six rings on the rotor shaft. The control is also expensive and is complicated, the latter being a serious factor in the maintenance of the equipment. Even when operating at the full low speed, the efficiency is considerably lower than at the full high speed.

In the table are given the efficiencies of a 40-hp. 60-cycle squirrel-cage two-speed motor. It will be seen that at full load the slow-speed efficiency is 4 per cent less than the high-speed efficiency. At one-quarter load the difference increases to 10 per cent. Of equal importance, and in some installations of even greater moment, is the power factor. At full load the difference between the high-speed and low-speed power factors is 8 per cent. At one-quarter load the difference is 20 per cent. If power is purchased and the rate has a power-factor penalty clause, when operating at low speeds the motor may be at a disadvantage on account of decreased efficiency and also an increased power rate.

EFFICIENCY AND POWER FACTOR OF 40-HP. TWO-SPEED SQUIRREL-CAGE INDUCTION MOTOR

	Full-Load		Half-Load		Quarter-Load	
Speed, R.p.m.	Efficiency, Per Cent	Power Factor	Efficiency, Per Cent	Power Factor	Efficiency, Per Cent	Power Factor
1,160	91	0.90	87	0.83	80	60
570	87	0.82	85	0.65	70	40

The efficiencies shown in the table are for a squirrel-cage motor that has two fixed speeds. If the motor has a wound-rotor and an external resistance is used to obtain intermediate speeds, the efficiencies at these speeds will be lower than shown in the table. Intermediate speeds of fixed value can be obtained only with constant loads.

There are drives of which the two-speed motor offers the best solution, but there are many others where a simple squirrel-cage motor with a variable-speed transmission will be the most economical. This arrangement has all the advantages previously outlined.

In some installations, such as for driving gas boosters, three-speed squirrel-cage motors have been used. In these cases the control equipment is located outside the motor room, away from gas leaks, and since the motors have no moving contacts the explosion hazard is greatly minimized.

On large fans two motors are sometimes used, one to drive it at slow speeds and the other at high speeds. The large motor has about double the rating of the small one and is arranged to be connected and disconnected by a magnetic clutch. In such installations, for a greater part of the day the required speed is such that the small motor can be used. It is only during the peak loads that the large motor is brought into operation. During these periods the small motor is disconnected from the line but is left connected to the fan.

Commutator-type polyphase alternating-current motors have been used for adjustable-speed drives. Speed variation with these motors is obtained by shifting the position of the brushes on the commutator. With one type the speed adjustment is constant only with constant loads. This motor has one set of brushes on the commutator. Another type has two sets of brushes that are shifted in opposite directions to change the speed. This machine has speed characteristics of an adjustable-speed shunt motor. Motors of this type can be obtained to give a speed range of four to one.

These motors are high in cost and more complicated in construction, and their maintenance costs will in general be higher than the induction type. The motors have the advantage of allowing an infinite number of speed adjustments within their range of operation.

A number of other means are available of obtaining speed adjustment with alternating-current motors, but those mentioned in the foregoing are the most commonly used.

Where a plant has a number of machines in a group that require adjustable speed, such as in a machine shop, the alternating current is sometimes converted into direct and direct-current adjustable speed motors are used. Where very wide speed ranges are required on large machines, such as planers, high-speed elevators, hoists and rolling-mill drives, variable-voltage control is used and this requires a motor-generator set to supply power to the driving motor on each machine. On the motor-generator set the motor is frequently of the squirrel-cage induction type, which makes the operation

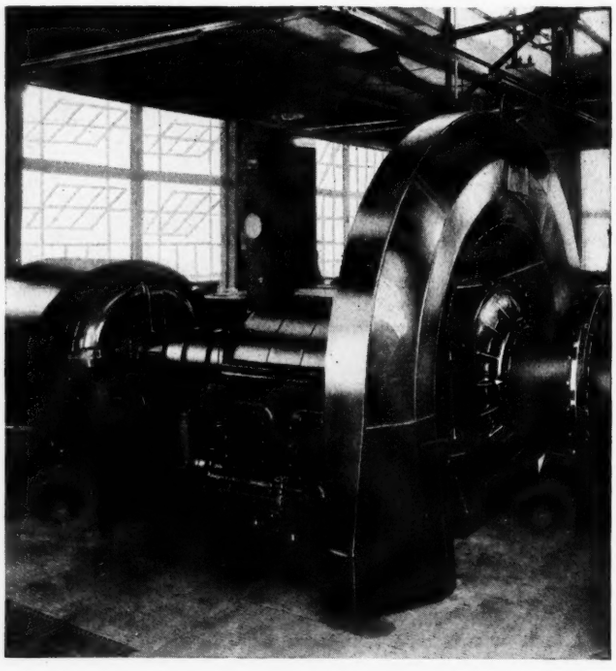


Fig. 4—Centrifugal-type gas booster driven by a three-speed squirrel-cage induction motor

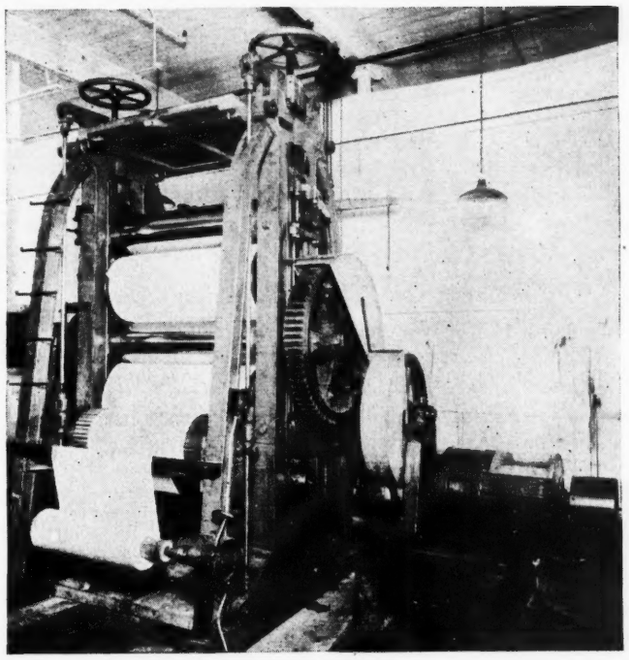


Fig. 5—Five-roll textile calender driven by a polyphase commutator-type adjustable-speed motor, having a speed range of 415 to 1,250 r.p.m.

of the set simple and reliable. The direct-current motor control is much more simple than for other methods, and a speed range as high as ten to one may be obtained.

From the foregoing it is evident that there is a wide variety of ways of obtaining adjustable speed with alternating-current motors. Whether constant-speed motors with variable-speed transmission should be used or some form of adjustable-speed motor, is a question that can be answered only by a careful study of all the conditions involved. In many cases the speed range required will dictate the use of a variable-speed transmission with a constant-speed motor. Where the capacity of the drive exceeds 150 hp., some form of adjustable-speed motor is generally used. Furthermore, with drives over 100 hp. the speed range required is in general not so great as with the smaller applications.

Letters From an Oil-Engine Operator

Running an Engine at Slow Speed

Dear Ed.: I am afraid you are fretting over a knock in your engine that is of no consequence.

Here in our town is a small ice plant and the owner is a refrigerating engineer. He is an up-to-date and coming chap who long ago saw the advantages of oil engines in his business.

One thing that attracted him was the possibility of varying the speed of his compressors to give him control over his output of ice in accordance with the trade demands.

During slack periods in the winter months he shuts down one compressor and runs the other just fast enough to maintain an ideal head and back pressure, and controls the output of the plant in this way. Obviously, it would be more expensive to work the plant at full capacity, store his ice and then shut the plant down, running only enough to keep the storage rooms below the freezing point.

On the other hand, to operate a compressor at full capacity for awhile and then shut down for a time to retard his output, would cause changes in temperature of the brine tank. This would cause fractured or cracked blocks of ice, which is not a satisfying condition.

It so happens that the engines he uses employ the solid-injection method of fuel injection and at slow speed his engines develop knocks. Not being thoroughly versed in oil-engine operation, this noise has been a constant source of worry and annoyance to him in spite of the fact that he has started up in May and run continuously 24 hours a day, seven days a week, until September of the same year without the engines missing a stroke.

At the end of the season he gives his equipment a complete overhauling and he has never found excessive bearing clearance or cylinder wear that would lead him to believe the noise to be due to loose main bearings, cranks, wristpins or to piston slap.

His maintenance costs have never been excessive, and he is exceptionally well pleased with the undisputable saving over the cost of steam or electric power, yet he frets over that slow-speed knock.

I have talked with him about this condition and explained that since there is no means of changing the time of fuel injection while the engine runs, his maximum combustion pressure will go up when the engine is slowed down and audible detonation will occur. This does no harm to the engine, as evidenced by the fact that he finds nothing wrong when he overhauls his equipment.

I have explained to him that this condition is due to the fact that by slowing the engine down, the time interval occurring between the point of injection, which is 19 deg. before dead center, and top center, increases in proportion to the decrease in speed, while the time interval required to bring about combustion remains approximately the same. Although the actual quantity of fuel injected is somewhat less than the amount required per full power working stroke, the maximum pressure mounts to a point somewhat higher than the normal maximum pressure at full load and full speed. I have been unable to convince him that in constant-speed engines, upon a change in the load there will be a weakened charge and detonation will not occur, whereas by slowing down he does not decrease the charge of fuel in proportion and obtains the lower power output through bringing about a fewer number of working impulses per minute.

I did convince him, however, that he was making a sad mistake by retarding his time of injection and thus eliminating the knock. When he did this the smoke appearing at the exhaust frightened him somewhat, and I was able to convince him that slow combustion might lead to other more serious troubles. In spite of all of this he continues to fret and fume about that little bump in his engines, and the more he listens to it the worse it sounds.

Returning to your case, I would say you should first convince yourself that there is nothing wrong with your engine and then forget about the knock. If you find that it is a piston slap, don't worry over that until the cylinders are worn so badly that the rings will no longer make an effective seal, which will probably be a long time.

Well, Ed, with all the saving that this fellow has made as the result of installing his oil engines, I think he could cut the price of ice a little, but he seems to be salting it all down in the old sock and all of us are contributors to his increasing wealth. E. O. Leseid.

Increasing Life of
TURBINE BLADES

By B. Anoschenko
Turbine Engineering Department,
Westinghouse Electric & Manufacturing Company

By subjecting blading to repeated and carefully controlled vibrations in an impact machine, alternating forces are set up similar to those incurred in service. The relative life of blading of various forms, materials and systems of lashing can be thus determined. The article tells how this is done.

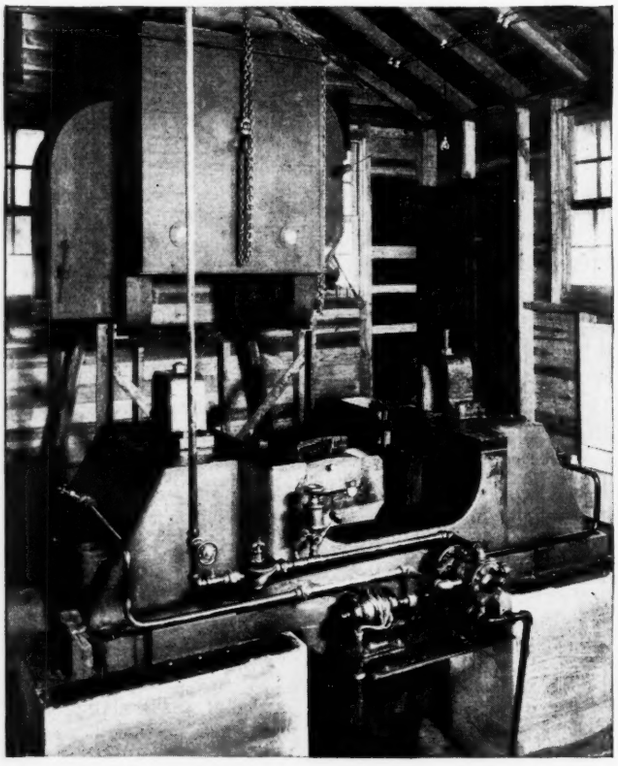


Fig. 1—Blade-testing machine with heater box lifted

NOTWITHSTANDING recent developments in the art of testing materials and advances in the method of calculating stresses in given shapes, theoretical methods of predicting beforehand the life for a detail of given shape have limited application. Appreciating these limitations under working conditions, the Westinghouse Electric & Manufacturing Company has resorted to experimental methods, old but reliable, to determine the life of turbine blading, which is always subjected to alternating forces resulting from intermittent steam flow between adjacent stages, vibration of rotating masses, or from torsional oscillations of the main rotors.

If a single blade, or a group of blades lashed together, be deflected from normal position and then released, vibration will set in with a specific constant frequency, characteristic of the blade or group, and with decreasing amplitude. Alternating stresses of the same frequency are set up in the blade and, if lashed, in the lashing wire as well.

These alternating stresses will slowly but surely ruin the material at the most affected section, and if such conditions continue, a point may be reached beyond which the material can no longer resist, and failure follows. In other words, the fatigue limit of the material has been passed. Forces which, under service conditions, can act on the blades and set them in vibration, may be divided into three groups.

The first is composed of forces of such frequency and magnitude that blade vibration started by one application will die out completely before the next application.

The second group consists of alternating forces such that blade vibration does not disappear between successive applications, but the frequency does not coincide with the natural frequency of the blades. That is, resonance does not exist.

The third group includes resonant forces, or such as have frequencies that coincide with the natural frequencies of the blades concerned. Segregation of these classes serves to direct the trend of investigation of vibratory blade failures and means of preventing them.

The various lines of work carried on in connection with blade tests, have been divided into the following main groups:

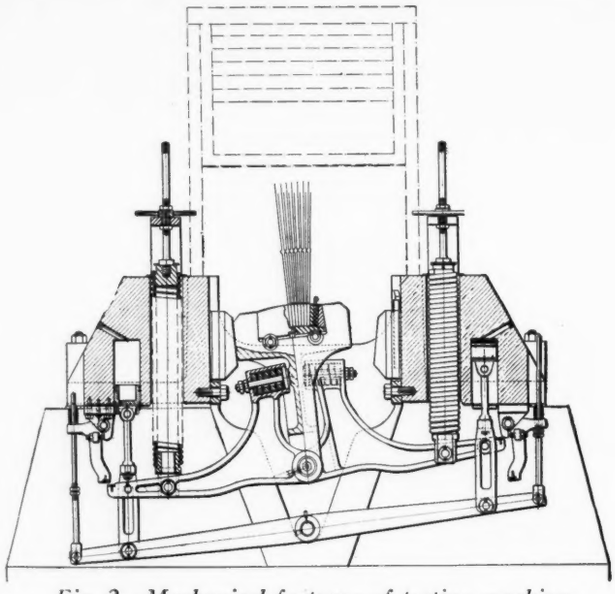


Fig. 2—Mechanical features of testing machine

(*a*) Investigation of the influence of manufacturing processes on the strength of blades subjected to vibration.

(*b*) Experimental comparison of the strength of various systems of lashing in blade groups.

(*c*) Checking and recording vibratory frequencies of blades after installation in turbine rotors before shipment.

A few years ago a special testing machine was built to determine the ability of various types of turbine blades to withstand the destructive action of vibration under different conditions of temperature. This machine was designed to subject groups of blades to vibration by means of the shock method; the shock being repeated, under constant conditions, a sufficient number of times to cause ultimate breakage.

Fig. 1 is a view of the machine with the heater box lifted off. Fig. 2 illustrates, in section, the mechanical features of this machine.

Turbine blades assigned for testing are assembled in a special block which fits into a hammer, as shown in Fig. 3. There are a number of these blocks, grooved to receive blades of different sizes, which are inserted and secured in the same manner as in a turbine rotor.

As may be observed in Fig. 2, the hammer, which is free to rotate on a stationary shaft, is moved back and

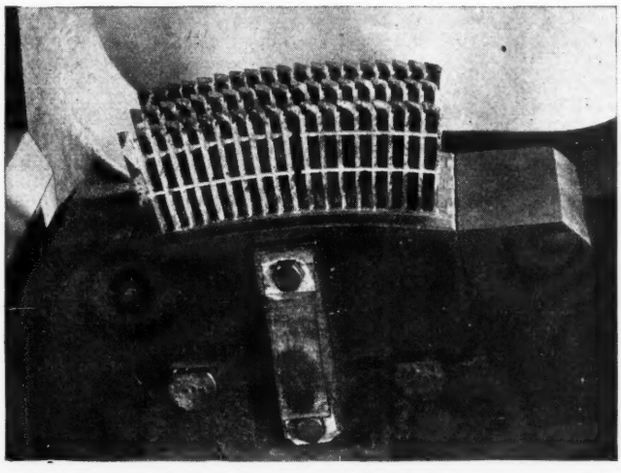


Fig. 3—Blades assembled for testing

forth by push levers actuated by large springs located at either side. Through a system of levers the springs are alternately set in tension and released by the action of pistons operated by compressed air.

When the hammer strikes the anvil, it produces a shock which results in deflection of the blades followed by vibration at their own natural frequency. As the initial deflection and the amplitude of vibration of blades depend on the velocity of impact of the hammer against the anvil, care is taken to regulate this velocity by changing the spring tension so as to produce a desirable blade deflection and the same impact at both ends of the stroke. These conditions are obtained by calibrating the impact force delivered by the hammer at either end of the stroke.

As shown in Fig. 4 the instrument used for this purpose consists of an electromagnet with a special armature carrying at its free end a thin brass strip having its tip formed to the shape of a ball point pen. By means of a beam bolted to the frame of the machine, the electromagnet is so supported that the ball point is pointed downward and rests on a sheet of zinc-oxide coated paper clamped to a bracket.

The magnet winding is connected through a transformer to a source of 60-cycle alternating current. When the hammer moves from one side to the other, the brass tip, oscillating with the armature at a frequency of 120 cycles, scribes a sinusoidal line on the zinc-oxide coated paper.

The number of oscillations per minute of the hammer is regulated by a rotating valve, which distributes com-

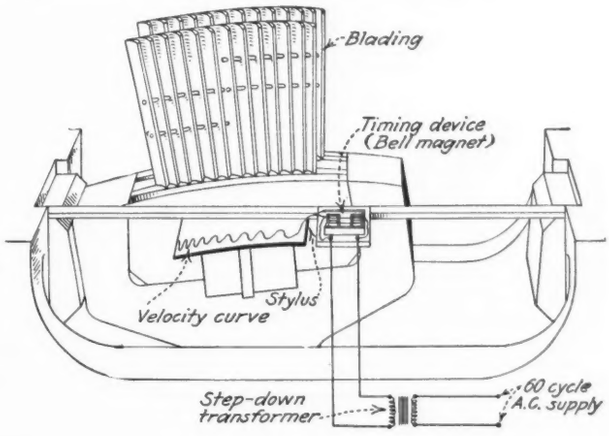


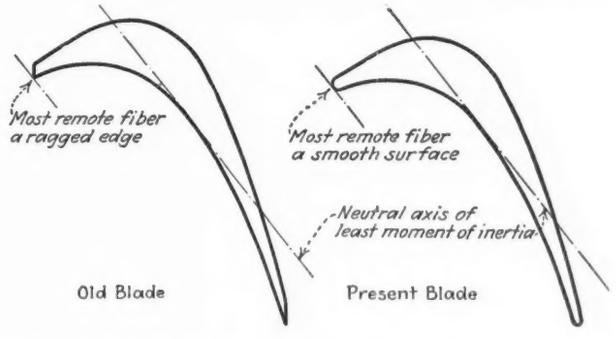
Fig. 4—Recording devices

pressed air to the pistons. This valve is driven by an electric motor, the speed of which is controlled by a rheostat. The distributing valve and driving motor are located on a small shelf in front of the machine, as shown in Fig. 1. The motor speed is so adjusted that the blade vibration will die out completely before another hammer blow is dealt.

In order to create and maintain constant temperature conditions similar to those encountered in service, a special heater box is provided. This is a double-walled casing containing special electrical heaters, insulated to prevent heat losses and equipped with temperature recording and automatic regulating means so that any desired temperature may be maintained.

Test Procedure

The test procedure is as follows: The block with the blades mounted therein, is placed in the hammer and the spring tension is adjusted so as to produce the desired amplitude of vibration and to develop exactly the same force of hammer blow on either side. The speed of the motor driving the distributing valve is set to make the intervals between hammer blows long enough for each



Figs. 5 and 6—Outlines of old and new blades compared

vibration to die out completely. When all adjustments have been made, the machine is started and the number of hammer blows is registered by a stroke counter. After each five hundred blows, or sooner, the machine is stopped and all the blades and lashings are examined

for cracks or failures, and the findings are recorded.

The results obtained by tests in this machine are purely comparative values of the resistance of different blades and lashings to vibration when all are subjected simultaneously to the same kind of shocks under the same temperature conditions. For example, the influence of different methods of finishing the blade edges, on the resistance of the blades to vibration, was determined by comparative tests with the same kind of material, size and length of blades, differing only in having sharp or rounded inlet and outlet edges.

For many years it was customary to finish the blade edges by grinding or milling operations so that the actual edges were formed by narrow surfaces parallel to the plane of rotation, as shown in Fig. 5. The ragged edges left by the milling or grinding operations were nothing more than a series of tears and scratches that acted to reduce the fatigue resistance.

Fig. 6 indicates what is termed a round-edged blade. The thickness of the edges is not changed. They are rounded at radii equal to half their thickness. Several groups, embracing various materials and sizes of blades, were used in the series of comparative tests of sharp- versus round-edge blades. The results showed that rounding the edges considerably increased the life and the factor of safety of vibrating blades.

On test, the round-edged blade ultimately develops only one crack, which grows toward the outlet edge until the blade breaks off with a fracture of the clean-cut

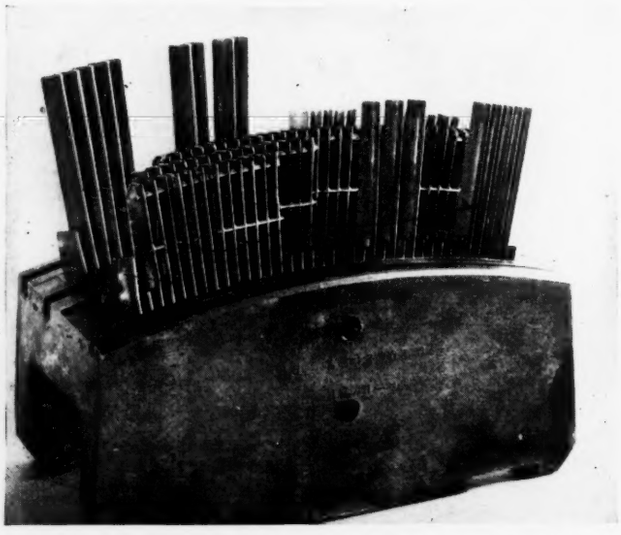


Fig. 7—Some samples of round- and sharp-edged blades that have been tested

fatigue type. The sharp-edged blade develops several cracks, simultaneously or successively, and one of them progresses until failure occurs. The round-edged blades break off at nearly a uniform height above the root, while those with sharp edges break off at various heights.

These conclusions may be verified by reference to Fig. 7, which shows a few samples from tests of this kind, and Fig. 8, which shows the progress of failure in groups of blades with rounded and sharp edges respectively.

Blades having carefully rounded edges but disfigured by sharp nicks such as are produced with a razor edge, were tested in comparison with sharp-edged and round-edged blades of the same size and length. This test showed a substantial depreciation in the resistance to vibration, as a crack starts at the nick and progresses rapidly until failure occurs. Ordinary indentations produced by handling or in service are much less harmful. Nicks left in the blades by a milling of the edges or a removal of the burrs are of the razor-edge character and must be avoided. These conclusions have resulted in a definite policy of carefully rounding the edges of all blades.

In an extensive series of tests, using blades of the same sizes, lengths and materials in the same test block, but varying the size, location and type of lashing, comparative data on blade group endurance under vibration at the

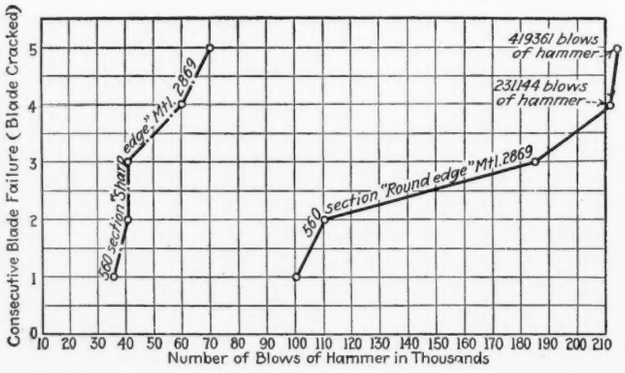

Consecutive Blade Failure (Blade Cracked)
0
1
2
3
4
5
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210
Number of Blows of Hammer in Thousands
560 section "Sharp edge" Mtl. 2869
560 section "Round edge" Mtl. 2869
41936 blows of hammer
231144 blows of hammer

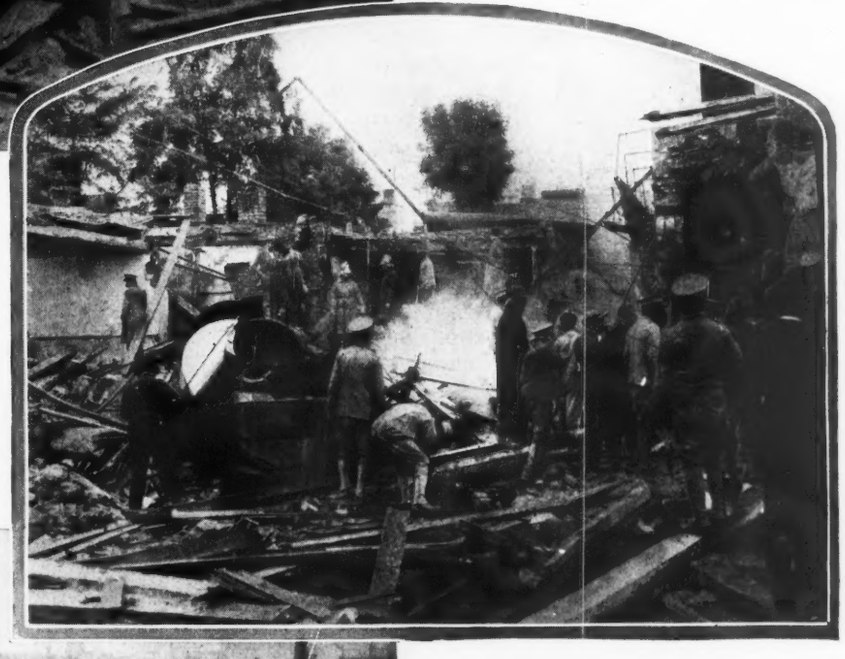
Fig. 8—Progress of failure in groups of blades with rounded and sharp edges

natural frequency were obtained and the best possible location of the lashing wire as well as its best size was determined for certain sizes of blades. In this manner blade design is being made to conform to the requirements of service as determined by actual test, to the end that the maximum period of dependable blade service may be obtained in every turbine.

Operating Methods that Save

Efficient power-service operation is impossible without extensive use of meters at the production end (the power house) and on distribution lines. This is particularly true in plants using large amounts of process steam. In the next issue the chief engineer of the Norwich (N. Y.) Pharmacal Company will outline the savings made by a comprehensive meter installation in his plant. In this plant the installation of integrating and recording boiler-room instruments saved 12 per cent of the coal formerly burned. Important savings were made by metering steam to departments. Complete records are kept of the distribution of live steam, exhaust steam and electricity.

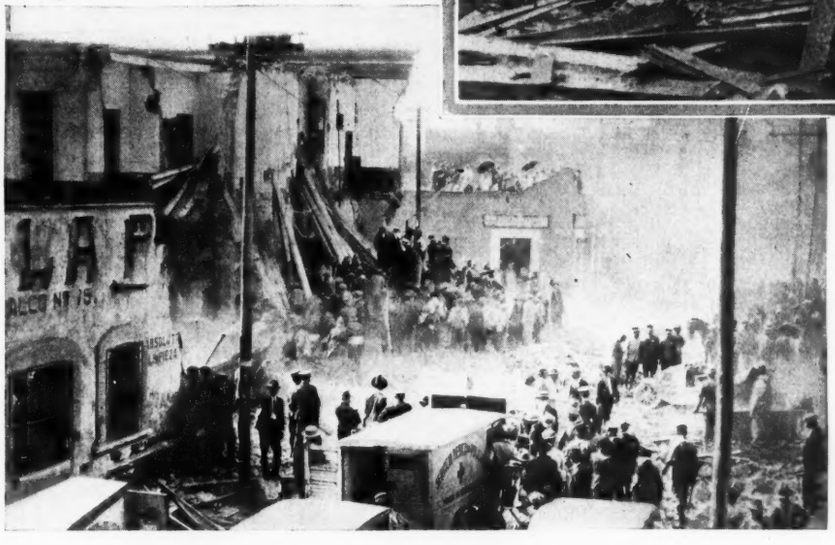
Even a Small Boiler Causes Havoc When It Explodes



THE explosion of a boiler in a bath house at Mexico City, reported in the July 3, 1928, issue of *Power,* in addition to causing the damage shown in the photographs, killed 28 persons and seriously injured 30 more.

The boiler was of the horizontal tubular type, 54 in. in diameter and 12 ft. long. It was of old-style two-sheet construction with longitudinal lap seams. These seams were double riveted, the rivet holes being $\frac{13}{16}$ in. in diameter and having a pitch of 3 in. The boiler was fitted with a 24-in. dome attached to the shell with one row of rivets. The tubes were three inches in diameter. There was a patch in the shell just below the dome, and the rupture of the boiler came through and started there. This rupture extended the entire length from head to head. The shell at the point of rupture showed considerable elongation, indicating that the material was of good quality.

There was no opening for a safety valve in the shell, and neither the dome nor the main steam line could be found. It is not known, therefore, whether the safety valve was mounted on the dome or on the main steam pipe. One theory advanced is that the accident was caused by overpressure due to a stuck or blocked safety valve. It is reported that the boiler water in that locality is so corrosive that safety valves frequently stick to their seats. Just exactly what occurred can only be inferred from the condition of the boiler after the explosion, as everyone in the immediate vicinity of the boiler was killed.

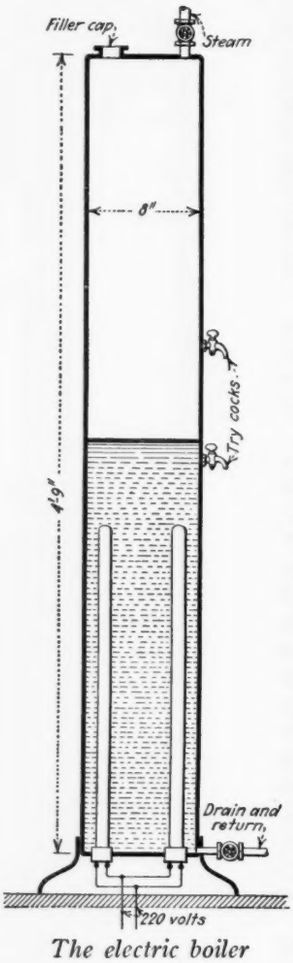


Burning Boiler Oil in Diesel Engines

By James M. Bloomfield

SINCE the fuel cost is the largest item in the operating charges of an oil engine plant, I undertook, and with encouraging success, some experiments to ascertain how far one could go in reducing fuel costs by using the cheaper boiler oil.

The Kamsach, Canada, municipal light and power plant contains three four-stroke-cycle air-injection Diesel engines totaling 600 hp. The price of fuel oil delivered to the storage tank was: Distillate, 15.3c. per imperial gallon; Diesel fuel oil, 14.5c., and boiler fuel oil, 10.2 cents, their respective gravities being 34 to 34 Baumé, 22-24 Baumé, and 10 to 12 Baumé.



The electric boiler

At first glance a saving of about 50 per cent between the first grade and last seemed well worth going after.

As we had been using the distillate for a considerable time, it was first thought advisable to substitute the Diesel fuel oil. This was done and a careful check was kept for a period of about nine months. Particular attention was given during the winter months to handling and transportation problems of the fuel oil from the time it was put on the spur track until it was pumped into the daily service tanks. The method and apparatus used were to a large extent, applicable to the heaviest grade.

We then decided to use the boiler oil. The analysis of this oil was as follows:

Gravity, at 60 deg. F., Baumé	12.25
Specific Gravity	0.984
Flash point, deg. F.	290
Burning point, deg. F.	325
Viscosity, at 122 deg. F. Saybolt, secs.	27
Water, per cent	0
Ash, per cent	0
Coke residue, per cent	8.45
Asphaltum, per cent	5.45
B.t.u. per lb.	18,635
Sulphur, per cent	0.508

The actual handling of the heaviest grade taxed our ingenuity more, I think, than all other phases of operating. At ordinary temperatures, say around 60 deg. F., little difficulty was experienced. But during early spring and fall, when the temperature was below zero, we had to devise special apparatus to facilitate handling, and after the month of October up until the end of February or perhaps even March we were forced to thin the oil with distillate to secure fluidity.

To enable us to handle the oil in colder weather, the special steam boiler shown in the illustration was constructed. This is used during the entire year.

A piece of wrought-iron pipe 8 in. in diameter, and 4 ft. 9 in. long was used, into the top and bottom of which steel plates were welded. The bottom was provided with two 2-in. couplings, also welded, through which two 5-kw. 220-volt immersion-type water heaters were put. A drain was provided at the bottom and this serves also as a return for the condensate. Two try-cocks indicated the height of the water. At the top a 3-in. filler cap and a 1-in. valve were suitably arranged. The whole was insulated with a 3-in. coat of asbestos cement.

Flexible metal piping, also suitably lagged with asbestos cord, carried the steam and condensate to and from the boiler.

Upon the arrival of the car of oil the boiler is filled with water, the pipes connected to the heating coils in the tank car and the switch turned on until the car is completely unloaded. During the summer months the boiler warms the oil until it is very fluid, whereas in the early spring and fall it does not get quite so fluid.

The transfer from the power-house storage tanks to the individual engine tanks is done by means of a motor-driven rotary pump, the suction of which is always under a head. No difficulty has been experienced, even when the temperature was below zero; however, as a precautionary measure all pipes are larger than is usual and are well lagged.

How the Oil Was Kept Fluid

The oil, when delivered to the engine tanks, has a consistency of molasses in summer months and something like hard grease in the early fall before we start thinning with distillate preparatory to winter operation. To keep the oil fluid, each of the service tanks was covered with an inch layer of cork, and at or near the bottom of each an immersion-type heater of 500 watts capacity is used to keep the temperature of the oil at about 130 to 150 deg. F. Besides the two main service tanks to each engine, there is an auxiliary 5-gal. tank suitably piped into the main fuel pipe to the fuel pump; this is filled with distillate for starting purposes, and all tanks are fitted with valves so that each individual tank can feed independently to the fuel pump.

Starting and running characteristics did not present the difficulties that we anticipated. We found we could start on this heavy fuel provided the engine was tuned accurately, but in ordinary daily operation it was more easily handled by starting on distillate and running on this oil for some ten or fifteen minutes before shutting down.

To obtain the most satisfactory results in running of the engine, some slight changes have been made. Heavy oils as a rule are slow burning, and therefore the admission point of fuel to the engine is of importance. The fuel valves of our engines were arranged to open at from 4 to 5 deg. before top dial center; this was advanced gradually until 8 deg. was reached, at which point the engine seemed to operate most satisfactorily. The pulverizer rings were reduced in number, the standard being four, until only one remained; this brought the blast pressure from 1,020 to 900 lb. per sq.in. at full load.

The temperature of the cooling-water outlet was also raised to around 130 deg. F.

It will be noted from the analysis that both the coke and asphalt contents were high; these had a deleterious effect on the exhaust valves, which became badly pitted after a run of 150 to 200 hours. The valves, being nickel steel, were affected much more readily than the cast-iron seats. After a few regrindings a point was reached where the valves had to be replaced by new ones. However, on inquiry from the engine makers, we found that renewable cast-iron rings could be purchased and fitted to the valves after the latter were turned down and steps cut in them; the new seats, after being fitted, were welded to the original valves. As a further precaution each valve had two fine circumferential grooves turned on the face. This has considerably helped, and now from 400 to 500 hours of operation can be had between regrinding periods.

Carbon trouble does not appear any more than when using lighter grades of fuel oil, and although the piston and rings are somewhat dirtier, the running of the engine is not affected, the rings being clear and free in their respective grooves.

Vibrations in Oil Engine Crankshafts

By E. C. Magdeburger

Bureau of Engineering, Navy Department

THE short article by W. E. Warner appearing in the July 31 issue is not quite free from confusing descriptions of types and symptoms of vibrations, and the writer wishes to amplify it with the following remarks.

First of all, let us understand that there are two types of vibration possible in any reciprocating engine. An oil engine is subject to vibration because it uses a crank mechanism and therefore inherits, in common with steam engines, air compressors and hydraulic plunger pumps, a common ailment.

Flexural vibration results from bending of the parts of the engine framing, such as bedplate, crankcase or similar members. The cause of flexural vibration is the faulty balance of the rotating and reciprocating masses of the engine and the presence of the so-called "free forces," or "rocking couples." It may be manifest in either the horizontal or the vertical planes and may be the cause of vibration of surrounding structures, such as foundations, buildings or the ship's hull in marine installations. Elaborate methods are available to balance more or less the rotating and reciprocating masses of any reciprocating engine. This type of vibration does not depend on the way the engine is coupled to its load, and if an engine does not vibrate on test, no vibration will develop after it is put in service.

For this type of vibration the masses of the injection-air compressor of the air-injection type of oil engine are, generally speaking, a detriment, and an oil engine of the airless injection type with the same number of cylinders is likely to be better balanced. There are several types of instruments used in measuring this type of vibration; among these is Geigers vibrograph.

Torsional vibration is the twisting and untwisting of the crankshaft system, quite independently of the torque impulses supplied by the working pistons of the engine. Here the question of balance of the rotating and reciprocating parts does not enter at all, and the most perfectly balanced engine may suffer from torsional vibration if the whole rotating shaft system, including the engine crankshaft and all the shafting coupled to it, has a synchronous, or critical, speed within the operating range of speed of the unit. Such a critical speed is a speed of synchronism, or coincidence between the number of impulses received by the shaft from the working pistons of the engine and its natural frequency; that is, the number of alternating twists and untwists that the shaft system will maintain when once twisted and then freed. The *"order"* of a critical speed is the number of vibrations per revolution, and the most dangerous major critical speed is of the same order as there are impulses per revolution. For instance, a four-cylinder triple-expansion marine steam engine may have a fourth order major critical in its operating range. Other major critical speeds correspond to two, three, five, etc., times the number of impulses. However, a multi-cylinder engine, whether steam or oil, is also subject to so-called minor critical speeds, which correspond to any harmonic component of the tangential effort diagram of the engine. Since every curved line may be built up of sinusoids of suitable maximum amplitude, period and phase, some of these harmonic components may have their own critical speed through the operating range.

Further details are unnecessary to show that torsional critical speeds depend on all the rotating and reciprocating masses and all the elasticity of the combined shaft system including the engine and the load absorber on one hand, and on the shape of the indicator diagram or tangential effort diagram on the other, and not at all on any balance of either rotating or reciprocating masses. To affect the location of the critical speeds of a given type of engine, one must change the existing mass-elastic system, by either enlarging or reducing one or more masses or the elastic links of shafting connecting them.

For a normal stationary installation working at one constant speed, this process is much simpler than for a marine unit operating through a considerable range of speed. Even then, no operator is expected to change the size of flywheel any more than he is expected to try improving the balance of the engine by bolting on a couple of hundred pounds to the crosshead of one of the cylinders of a steam engine.

The best-known commercially available instrument for recording torsional vibration is Geigers torsiograph. With the aid of this instrument and with competent personnel to make the necessary calculations, any reputable engine builder is prepared to guarantee that an engine coupled to a given load operates at a speed sufficiently far removed from any dangerous critical speed to cause no anxiety to the operator.

The reliability of the shallow pan of water, recommended by Mr. Warner, to determine torsional critical speeds is very questionable to say the least, since torsional vibration need not shake the framing of the engine or be otherwise objectionably noticeable to the operator, as many disasters have shown. Should repeated breakages of shafting or other parts attached to it occur or excessive wear of gears and parts of valve gear or attached auxiliaries be noted, the operator is better advised to consult a competent engineer with a view of experimentally determining the location of critical speeds and for correcting the evil. The buyer of new equipment consisting of multi-cylinder engines, especially of the high-speed type, would do well to insist, as does the United States government, that torsiograph tests be conducted on the engine as set up before the final acceptance of the installation.

THE CENTRIFUGAL PUMP

Its Possibilities and Limitations

By M. Spillman
Consulting Engineer
Worthington Pump & Machinery Corporation

A CENTRIFUGAL pump is usually part of a piping system, and its object is to establish and maintain therein a flow of a liquid. It accomplishes this by its ability to lower the pressure at its intake or suction side and to create a higher pressure at its discharge end.

What are the physical limitations to a reduction in pressure?

The lowest possible pressure in a vessel containing water at a given temperature is the pressure at which boiling begins. These values can be found in all steam tables. A few values are given in the accompanying table, in which the figures for "Practical Suction Lift" allow the pump to have at all temperatures a suction head of 18.4 ft. above the absolute pressure at which water boils. This figure is arrived at by the following reasoning: All pump manufacturers have adopted the practice of rating their pumps for total suction lifts not exceeding 15 ft. with cold water. Tests and experience have shown them that a well-designed pump of normal type is sufficiently flexible and will not lose capacity and efficiency at a total lift of 15 ft. When this lift is exceeded, the pump begins to show signs of reduced output without a proportional reduction in power consumption. If a test were made with suction lifts varying from 15 to 20 ft., little or no reduction in capacity or efficiency would be noticed for lifts slightly above 15 ft. At 20 ft. suction lift, however, the reduction in capacity and efficiency would be pronounced.

As will be shown later, the water within the pump flows to points of much lower absolute pressure than existing at inlet, before its pressure is increased again. At those points its absolute pressure will drop to zero when the suction lift appreciably exceeds 15 ft. Steam is formed, the water leaves the walls (cavitation), the stream lines contract, and the quantity and efficiency are reduced. This is the phenomenon known as cavitation, and is an intermittent process in which vapor pockets form and collapse. When they collapse, the water strikes the metal a hard blow that induces severe wear. First-stage impellers and diffusion rings of multi-stage boiler-feed pumps always show more rapid erosion than those in the succeeding stages.

Old habits are often hard to break. For instance, most boiler-feed pumps are still installed having a head of only 10 to 12 ft. in excess of the pressure head corresponding to the boiling point, with water in the supply tank at evaporation temperature and pressure.

In this article, the first of two, the author discusses the possibilities and limitations of the centrifugal pump as they affect the piping system of which the pump is part. He refers especially to pumps serving the generation and condensation of steam. In next week's issue he will discuss the action of the pump itself.

Pumping Systems

If the pump impeller is rotated at a peripheral speed exceeding a well defined minimum, the liquid will flow through the system at such a rate that a balance exists between pump and system; the head generated in the former is exactly equal to the resistance prevailing in the latter.

Fig. 1 is the arrangement commonly selected where water is to be pumped to a delivery tank at elevation E_1 from a suction basin at elevation E. Both surfaces are under atmospheric pressure. The pump must generate a total head equal to the height of the water level in the discharge basin over the suction basin, plus the head necessary to overcome the friction in the system. The curve on the right of Fig. 1 shows the total head as the sum of static and friction heads, the latter increasing as the flow increases in the approximate ratio of the square of the rates.

Selection of Pipe Sizes

It will be found that modern centrifugal pumps have small suction and discharge openings with resulting high velocities of flow at these points. These are perfectly in order in view of the steady flow. Calculation of the permissible friction head losses will readily show whether suction and delivery pipes are ample or should be enlarged by suitable increasers. In the majority of installations such increasers will be beneficial.

Abrupt bends should be avoided. They cause great loss of head and create disturbances extending far upstream and downstream. Fig. 2 shows that water does not flow with uniform velocity in a short-radius elbow, nor parallel to its contour.

The head losses in elbows are greatly influenced by the proximity of other elbows, as for instance the loss in a 180-deg. bend is more than twice the loss of a 90-deg., while a 45-deg. turn causes less than half the loss of a 90-deg. of equal curvature. For single 90-deg. short-radius elbows one may assume a loss of head of $0.85 \frac{V^2}{2g}$, and for the so-called long-radius ell, $0.4 \frac{V^2}{2g}$.

It is especially objectionable to place short bends at pump inlet and discharge, because the disturbances cre-

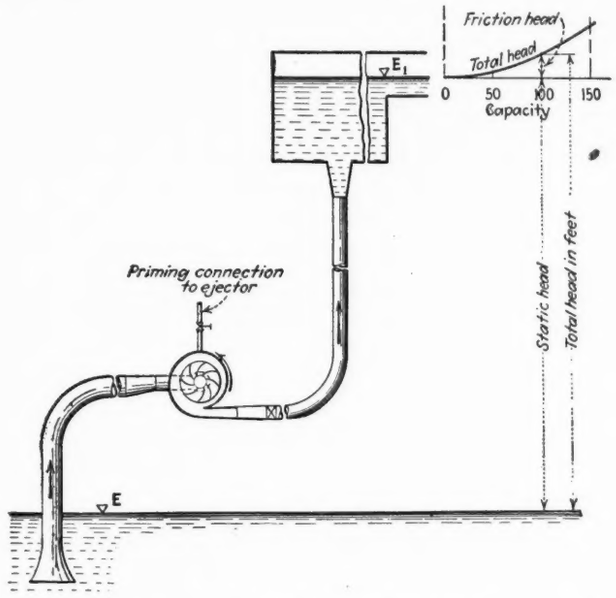


Fig. 1—A simple pumping system

ated react unfavorably on the energy transformation in the pump itself.

The Intake and Outflow

The intake pipe should be at least two feet below low-water level. This will prevent air being drawn in, provided the pipe is sufficiently enlarged (to 1½ to 2 times

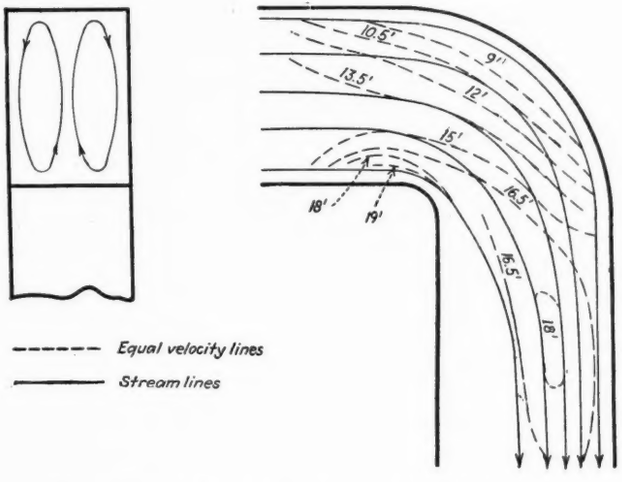


Fig. 2—Real flow in an elbow with 12.5 ft. per sec. average velocity

the diameter of the suction opening at pump) by means of a bell or cone.

The velocity at the outlet from the discharge pipe must be created by an excess pumping head equal to $\frac{V^2}{2g}$. It is, therefore, good practice to reduce V by means of increasers, especially in low-head installations, such as condenser circulating pumps, where the head energy that can thus be regained is a substantial part of the total head.

For the system head it is immaterial how little the pump is below or above the suction-water level, but centrifugal pumps are more flexible, quieter, and last longer if they receive water under a substantial absolute head.

Fig. 3 shows that theoretically water at 60 deg. F. can be elevated 33.4 ft. over a free surface under atmospheric pressure. But this is a static condition. If water flows upward owing to the displacement caused by the pump, located over the intake level, the maximum height at which the pump can be placed is evidently less than 33.4 ft., because a certain amount of the available head

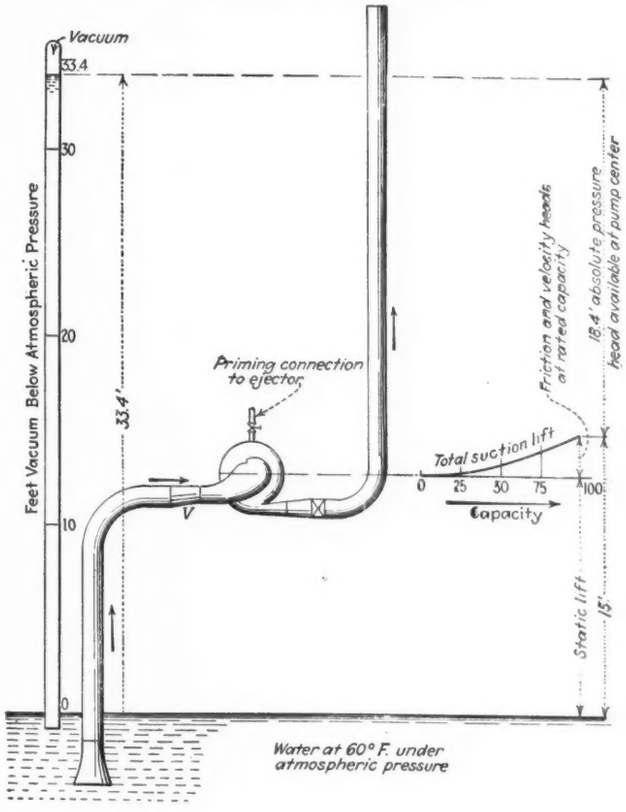


Fig. 3—Pump suction lift is less than barometer height

is consumed to accelerate the water from rest to the velocity in the suction pipe. This value is $f\frac{V^2}{2g}$ where V is velocity and f a factor which may be taken as unity if the water is accelerated gradually as it enters the suction

SUCTION LIMITS OF CENTRIFUGAL PUMPS

Temp., Deg. F.	One Atmosphere in Feet of Water Column	Abs. Pres. Ft. Water Column at Which Water Boils	Theoretical Suction Lift	Practical Suction Lift	Practical Suction Head
60	34	0.6	33.4	15	....
100	34.2	2.2	32	13.6	....
140	34.4	6.8	27.6	9.2	....
160	34.5	11.2	23.3	4.9	....
180	34.7	18	16.7	....	1.7
190	35	22.3	12.7	....	5.7
212	35.4	35.4	0	....	18.4

pipe. This is accomplished by a bell- or cone-shaped entrance. The friction head loss in the suction pipe will further reduce the maximum attainable height. If we subtract the sum of the above-mentioned velocity head and friction-head losses from the theoretical figure of

33.4 ft., we arrive at the maximum suction lift. But this is another theoretical figure as will readily be perceived if one takes into account the adverse influence of

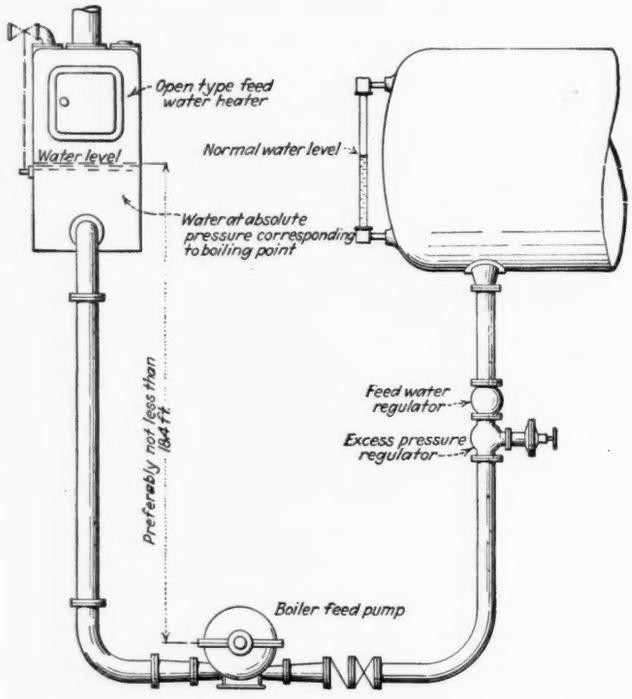

Open type feed water heater
Water level
Normal water level
Water at absolute pressure corresponding to boiling point
Preferably not less than 18.4 ft.
Feed water regulator
Excess pressure regulator
Boiler feed pump

Fig. 4—A boiler feed pump should be at least 18.4 ft. below the level of water in the heater

very low absolute pressures on pump performance. Fig. 3 therefore allows a maximum total lift of 15 ft. for a pump handling cold water, likewise Fig. 4 shows

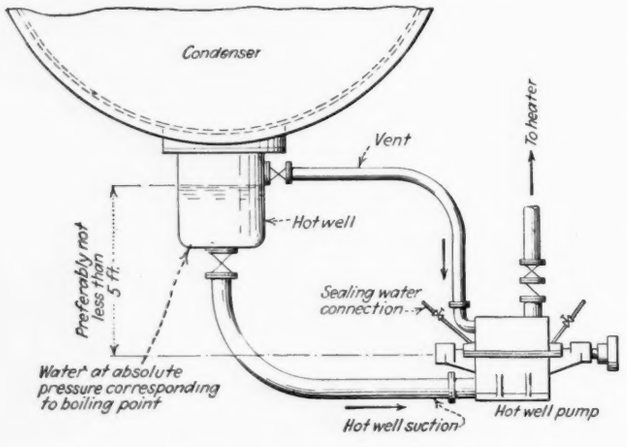


Fig. 5—Proper hotwell pump connections are important

a boiler feed 18.4 ft. below the surface of the water in the heater with correction for velocity and friction heads.

Condensate Pumps

Once the beneficial influence of ample head on the suction is realized, it will generally be possible to find means to locate the pumps at proper levels, except perhaps the condensate pump, Fig. 5. This unfortunate pump handles water at temperatures within one or two degrees of the boiling point, and the author knows of a number of instances where its center line is only 18 in. below the high-water level in the hotwell. The output of these pumps is governed entirely by what the condenser supplies. In order to adapt their characteristic to the system head, they operate with varying head on the suction, which, however, must not be higher than the vertical distance from pump center to high water level in the hotwell. The piping between hotwell and pump is usually short. It should be proportioned for a velocity not exceeding 3.5 ft. per sec. Whenever possible, use pipe bends instead of fittings, to reduce the possibility of air leakage into system. Carry a vent pipe from the vent opening in the suction end of the pump casing to a point above high water level in the condenser hotwell. Seal the pump stuffing boxes with cold water under a pressure of at least 15 lb. gage.

Pressure Stability of High Pressure Boilers

By Elmer S. Smail

THERE are two ideas about the design of boilers to operate at pressures on the order of 1,000 lb. per square inch. One idea is that the super-pressure boiler will be substantially the same as the moderate-pressure water-tube boiler except with thicker material to withstand the greater pressure. The other opinion is that the ultimate design will be radically different from present equipment.

Up to date the first idea seems to be the accepted one and on that basis it may be profitable to speculate on how the operation of super-pressure boilers will compare with their lower pressure equivalents.

Let us picture a 3,200-sq.ft. boiler with a steam space of 90 cu.ft. and a water space of 300 cu.ft., not an unusual ratio. Assume this boiler operating at rating and normal water level, at some known pressure It will then contain 300 cu.ft. of water at the boiling temperature and 90 cu.ft. of saturated steam at the same temperature. To simplify the situation assume that the water content is all at boiling temperature and that all of the steam is in the steam space. Neither of these assumptions is strictly true, but as we are after comparisons no appreciable error is introduced.

Now let us close the steam outlet and the feed inlet, and maintain the firing at the same rate. Naturally, the pressure will increase, and we will calculate the time required to raise the pressure 50 lb. per sq.in. This necessitates figuring the internal energy of the contents before and after the pressure increase. This time will be an inverse measure of the sensitivity of the boiler, i.e., the shorter the time, the more sensitive the boiler.

For this particular boiler at 100 lb. absolute pressure:

Energy in the water,	15,000	lb. at	298.7 B.t.u.	=	4,470,000 B.t.u.
Energy in the steam,	20.35	lb. at	1,104.6 B.t.u.	=	22,479 B.t.u.
Energy in the boiler,	15,020.35	lb.		=	4,492,479 B.t.u.

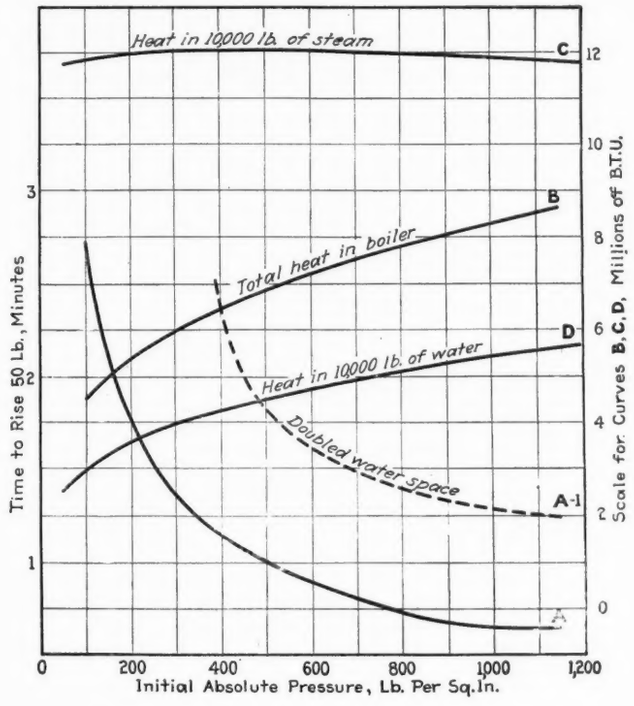
For same boiler and contents at 150 lb. absolute:

Energy in the water,	14,990.45	lb. at	329.7 B.t.u.	=	4,942,351 B.t.u.
Energy in the steam,	29.9	lb. at	1,110.1 B.t.u.	=	33,192 B.t.u.
Total at 150 lb.	15,020.35	lb.		=	4,975,543 B.t.u.
Total at 100 lb.	15,020.35	lb.		=	4,492,479 B.t.u.
eat added (= gain in internal energy)				=	483,064 B.t.u.

This boiler at normal load absorbs heat at the rate of 178,554 B.t.u. per minute, so the required amount of heat will be absorbed in 2.71 minutes.

If we take the same boiler built stronger, filled to normal level at 200 lb., we find that it will take 1.75 minutes to raise the pressure to 250 lb.

The solid line *A* in the chart shows the time required to add 50 lb. to various initial pressures. A fair amount of tolerance must be allowed at the higher pressures as many of the characteristics of steam are undetermined at these pressures. It is probable that the temperatures and total heats up to 1,200 lb. are quite accurate, but specific volumes and internal energy are quite approxi-



Heat, pressure and time relations in boiler

mate. The tendency of the curve in all probability will be little changed by later data.

An examination of this curve shows that at 1,150 lb. this boiler is almost twice as sensitive as at 350 lb. and over four times as "tender" as at 100 lb. Curve *B* shows the total B.t.u. in the boiler at various pressures and curve *C* the variation in the total heat of steam with pressure.

Large Drums Correct Sensitivity

To correct this sensitivity at the high pressure we can increase the volume of the boiler, and obviously, if we double the steam space and the water space for 1,150 lb., we will have a boiler just as steady with respect to pressure as the original unit at 350 lb. Doubling the steam space alone has very little effect, but doubling the water content assists materially. The dotted curve *A*–1 gives the time elements for a boiler with 600 cu.ft. of water space and 90 cu.ft. of steam space. The apparent conclusion is that a super-pressure boiler should have greater water capacity per unit of heating surface than a low-pressure boiler. Increased water capacity means increased drum volume, preferably submerged.

Now let us see what happens to boiler drums when the pressure is raised. At 200-lb. pressure a 42-in. drum is about $\frac{7}{8}$ in. thick with the butt straps about two-thirds the plate thickness. As we increase the pressure these thicknesses increase in proportion, and when we get above 500 lb. we not only get plates impossible to handle, but a seam of impossible thickness (requiring rivets comparable to an automobile axle) extending around a large part of the drum circumference. This problem has been solved very successfully, mechanically speaking, by the hollow forged-steel-seamless drum, several of which have been built 40 in. diameter and 5 in. thick.

Mechanically these drums are ideal, but unfortunately, for equal volume, they cost decidedly more per pound than drums made of plates, with the result that super-pressure boilers are usually offered with less drum space than low-pressure boilers. This practice has been defended by citing that a cubic foot of steam and water contains so much more energy at the high pressures than at the low that a smaller capacity is justified. This is true from the energy standpoint, but it ignores the instability of pressure which is an item of some importance.

Conclusions

As the writer sees it, the following courses might be followed:

1. Provide super-pressure boilers with a volume as great as or greater than moderate-pressure boilers and accept the increased price as a debit against the expected fuel efficiency.

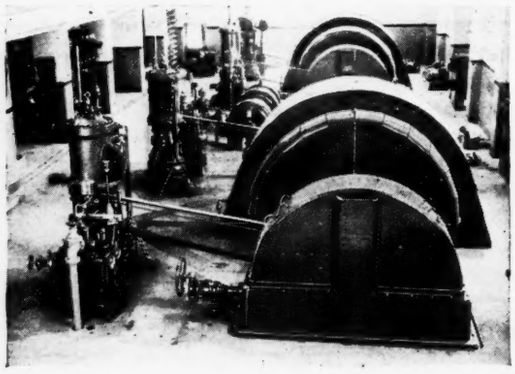
2. So synchronize the firing equipment with the steam output of the boiler or the electrical output of the generator connected to it, that a variation in demand immediately adjusts the rate of firing. This is going to be a complicated process with the various firing devices and will add another expensive accessory to the already expensive plant.

3. Maintain the operating pressure so far below the safety valve setting that pressure increases caused by decreases in load can be caught by operators before the safety valves pop. This is uneconomic because it renders useless an appreciable part of the pressure working range of the expensive boiler and subjects the turbine to a varying steam pressure.

4. Maintain a rate of firing and a generator output so constant that pressure changes will not occur even with the sensitive boilers. This without doubt will be very difficult except for base load plants.

Some Pump Costs Based on Recent Bids Received by the City of Evansville, Ind.

	Item	Quantity	A	B	C	D
I.	20 million gal. (pump) 165-ft. head, including steam turbine and reduction gears	1	$21,540.00	.....	22,000.00	25,450.00
II.	20 million gal. centrifugal pump, 52-ft. head, with 440-volt slip-ring motor	1	5,771.00	5,750.00	4,900.00	5,400.00
III.	12 million gal. centrifugal pump, 52-ft. head, with 440-volt slip-ring motor	1	4,441.00	3,800.00	3,600.00	4,050.00
IV.	8 million gal. centrifugal pump, 52-ft. head, with 440-volt slip-ring motor	1	3,117.00	2,875.00	2,300.00	2,550.00
V.	3,000 g.p.m. hydraulic turbine-driven cent. pump unit	1	1,905.00	2,700.00	1,670.00	1,300.00
VI.	9 cu.ft. per min. single, 2-stage steam jet air ejectors	2	1,600.00	.....	2,250.00	1,965.00
VII.	22 g.p.m. at 40-ft. head electric-motor-driven centrifugal pump	1	225.00	550.00	225.00	340.00
VIII.	22 g.p.m. 40-ft. head waterwheel-driven centrifugal pump	1	800.00	700.00	365.00	550.00



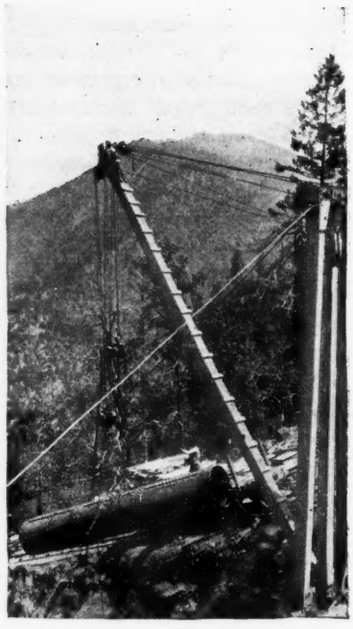


Fig. 1 (Left)—Power house and penstock

Fig. 2 (Above)—Two 35,000-hp. units installed in the power house

Fig. 3 (Right)—A section of the penstock being lowered into place

Highest Head Hydro-Electric Development in America

By Edgar A. Brown

Assistant Engineer, Constant Angle Arch Dam Company

Because the description of a record-breaking hydro-electric project is hardly off the press before its fame is lost, the title of this article was selected with some hesitation. High-head plants are numerous on the Pacific Coast and particularly in California, where the rapid fall of its mountain streams makes possible developments through very high heads without excessively long conduits. The recently completed power house No. 1 of the Bucks Creek development of the Feather River Power Company is designed to operate under a maximum static head of 2,561 ft., so that, for the time being at least, this new development is individual with respect to its operating head.

Plumas County, California, is the location of the development, power plant No. 1 being situated on the north fork of the Feather River. Fifty square miles of the most productive drainage area in the State of California feed this development. About 75 per cent of the utilized area is tributary to the reservoirs of the system, which affords a nearly perfect regulation of the runoff. This development was born of investigations and studies, dating as far back as 1902, of the storage possibilities of Bucks Meadows as a link of a projected development on the middle fork of the Feather River. Surveys early in 1924 indicated the practicability of development of Bucks Creek waters within their own watershed, and the former plan was abandoned. Moreover, by locating the power house on the north fork of the Feather River, expensive transmission lines were avoided. The Great Western Power Company of California, to whom the entire output of Bucks Creek plant is to be sold, had already built one transmission line paralleling the river on the bank opposite the plant, and the tie-in now consists of a double span across the river.

Two overhung impulse-wheel 20,000-kw. generating units operate under head of 2,561 ft. Plant featured by reservoir system collecting entire yield of watershed. Penstocks of special design and system used for remote indication and control.

As shown on the map, the principal units of the development are: A main storage reservoir of 103,000 acre-feet capacity, in what is locally known as Bucks Meadow; a diversion reservoir lower down on Bucks Creek from which the waters are diverted through a tunnel and thence into the natural channel of Grizzly Creek; Milk Ranch conduit and Three Lakes reservoir,

the water from which is regulated in Bucks Creek diversion reservoir; Grizzly Creek forebay, which receives the entire yield of the watershed and diverts it into the pressure tunnel leading to the penstocks; two penstocks leading down the mountainside to the power house, and the power house and high-tension switchyard.

Construction of this development was started early in 1925. Much preliminary work was necessary, the wild nature of the country and comparative lack of transportation facilities necessitating clearing and road building. Fortunately, however, the main line of the Western Pacific Railroad follows the north fork of Feather River on the opposite bank from the power house.

The work on the dams, reservoirs and the Milk Ranch conduit was at the mercy of the seasons. On these units of the project the working year averaged from June 1 to Dec. 1, exceedingly heavy snows impeding any progress during the winter and spring months. Work on the tunnels, of course, was uninterrupted, as was the work on the power house and penstocks, although in the case of the penstocks one could drop from a snow-bound region to comparative summer in the space of a few minutes.

Preliminary surveys and examinations of the site for the Bucks Creek storage dam indicated the advisability of a rock-fill type structure. In order to conserve as much as possible of the runoff during construction and still not impair the stability of the structure, a concrete gravity type retaining wall was first constructed to form the upstream toe of the completed dam.

At the lower diversion point on Bucks Creek and for the forebay, the dam sites lent themselves well to concrete dams of the constant-angle arch type. Both dams were quite similar in general dimensions, such as span, height, etc., though at the forebay site foundation conditions necessitated deep excavations. The full water load on these dams will develop a maximum compressive stress in the concrete of less than 500 lb. per square inch.

Milk Creek Conduit

Milk Ranch conduit diverts the waters of Milk Ranch Creek and Three Lakes reservoir and discharges them into Bucks Creek diversion reservoir. This conduit consists of 8.05 miles of buried, soil-proofed, welded steel pipe, the diameters varying from 23 in. at the intake end to 36 in. at its terminus. The reason for the increase in diameter from intake end to discharge end is that in its course the conduit intercepts a number of streams which are diverted to augment its flow. A conduit of such length was justified by the high yield of its diverted area and the excellent regulation afforded in Bucks Creek diversion reservoir.

The upper tunnel, which receives water from the Bucks Creek diversion reservoir and carries it through the ridge between Bucks Creek and Grizzly Creek, is 5,650 ft. long. The flow through the tunnel is controlled

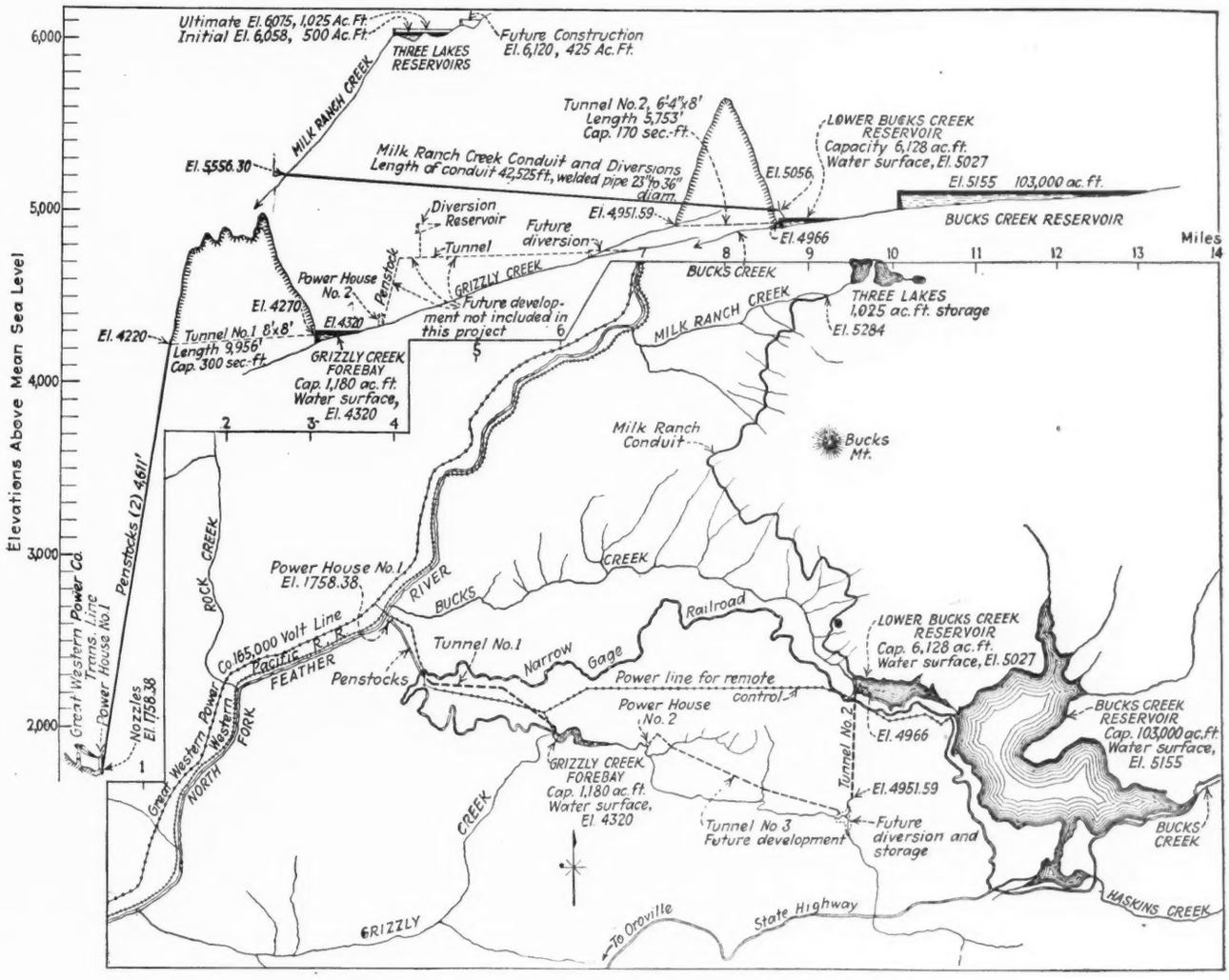


Fig. 4—Map and diagrammatic profile of Bucks Creek development

by a 5-ft. cylinder gate located in a concrete tower in the diversion reservoir. The lower tunnel carries waters from the forebay through the same ridge at a lower point, to its portal at the head of the penstock line. Unlike the upper tunnel, it is under pressure, the static head at its lower portal being 100 ft. Control is effected by two 36x72-in. sluice gates in a concrete tower in the forebay.

Representing the most advanced type of high-head water conduits, the penstocks are the result of careful design, fabrication and test. Exhaustive analyses were made of the conditions under which these pipe lines would operate, special study being given to the subject of water hammer. Some recent ruptures on high- and moderately high-head penstocks have been attributed to water-hammer conditions set up by too rapid gate closures, the failures usually occurring in the middle or in the upper third of the pipe line. With these experiences of others as a warning the Bucks Creek penstocks were so designed that in case of instantaneous closure of the gate valves at the power house the resulting water hammer would produce a stress in the pipe material of not more than 70 per cent of the elastic limit of the steel.

Penstock's Construction

Many types of pipe were investigated for the structure, with the result that triple-riveted double-butt-strap was employed from the upper end of the line down to a point where the static head was 1,249 ft. This section of the line ranged from 54 in. in diameter, $\frac{5}{8}$ in. thick at the upper end, to 42 in. in diameter, $1\frac{1}{4}$ in. thick at the lower end. From here on to the power house the line is made up of "Ferrum" banded pipe, varying in thickness from $\frac{19}{32}$ to $\frac{63}{64}$ in. exclusive of the bands, and with a uniform inside diameter of 36 in. At the power house each line branches to two 26-in. pipes leading to the nozzles.

The two penstocks are laid parallel, seven feet apart,

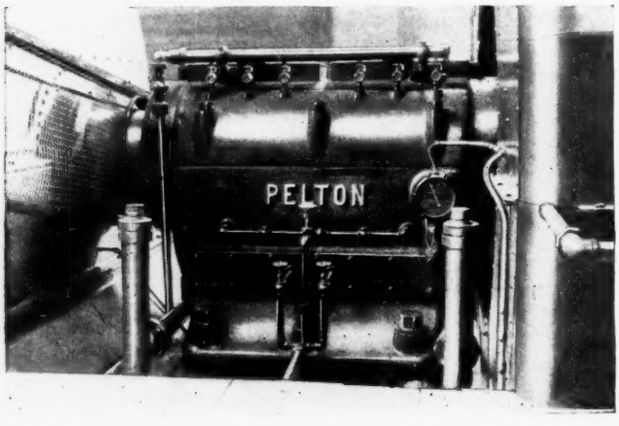


Fig. 5—One of the main unit bearings

Included in the bearing equipment is a flood oil system with sight-flow indicators, pressure oil lubricating system for use in starting and stopping the unit, a cooling-water system and a temperature indicating thermometer with electric alarm contacts. When the picture was taken, the unit was running at full load and the bearing temperature was 113 deg. F.

and are supported on concrete piers. At each change in alignment the pipes are secured by gravity-type concrete anchors. Each section of pipe between anchors is provided with expansion joints. Protection against collapse from sub-atmospheric pressure is doubly insured by the strength of the pipe shell and adequate air-valve installations as an additional precaution. The penstocks are equipped with gate valves next to the nozzle in the power house and butterfly valves at the tunnel portal. Fluctuations of flow are balanced by a surge chamber excavated from the tunnel to the surface a short distance from the portal. The measurement and log of the flow of water through the penstocks is maintained by a flow meter.

Structural features of the power-house building are a concrete substructure on rock, a structural-steel frame, reinforced-concrete superstructure, composition roof and steel sash. The switchboard, battery room and switch

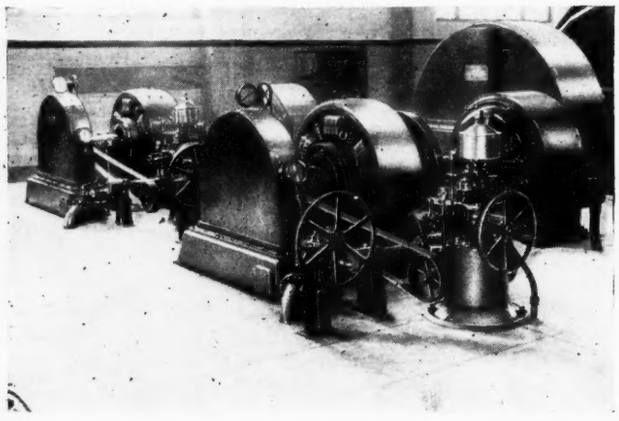


Fig. 6—Waterwheel-driven exciter equipment with oil-pressure governors for speed control

cells are in an annex above the operating floor. The building is equipped with two 50-ton traveling cranes, each having a capacity of 100,000 lb. on the main hoist and 20,000 lb. on the auxiliary hoist, the lift being 33 ft. from the operating floor to the crane rail.

The equipment consists of two horizontal double-overhung impulse wheels, each rated at 35,000 hp. under the head and speed given in the accompanying table of equipment. Each unit is provided with an exciter impulse wheel developing 450 hp. at 900 r.p.m. A feature of the hydraulic control is a gate valve on a cross-connection between the penstocks, which allows the use of both penstocks on one unit, thereby reducing friction losses in the pipe on low load.

Each wheel has one main power nozzle and one auxiliary relief nozzle. Speed control is automatically effected by means of a Pelton self-contained inclosed, oil-pressure, direct-motion governor, actuated by a central oil pressure system for both units.

Generators are of the revolving field type, rated at 20,000 kw. at 80 per cent power factor. Three-phase 60-cycle current is generated at 11,000 volts. Ventilation of the generators is effected by air washers at the rear of the power house, the air passing through the generators and out into the atmosphere through ducts at the front of the building.

Remote Control

A feature of this development is the system of remote indication and control that has been devised. By means of it the opening and closing of the valves at the reservoirs and intakes to the tunnels are actuated from the power house by dialing predetermined numbers for each valve position. Impulses from the dial switch operate selector relays and close the correct contact in the valve-house. Also, it is possible for the operator to select any

one of ten valve positions at the main storage reservoir and upper diversion tunnel, or two positions at the intake to the lower tunnel. Conversely, he can read from his operating board the position at which any valve is set. This is accomplished by a multi-tap transformer at the valve and a voltmeter at the power house, a compensating device being installed in the voltmeter circuit to correct for variation in line voltage. Furthermore, the water

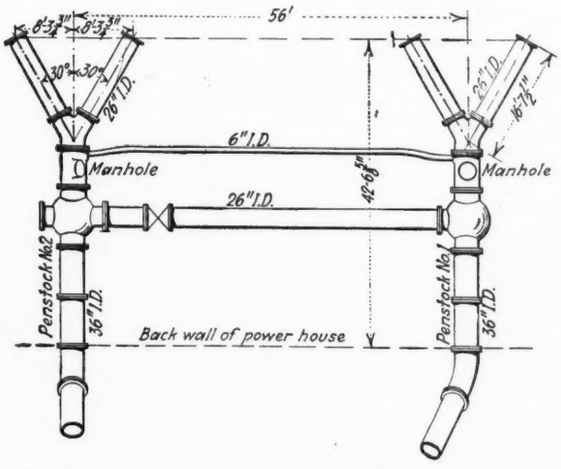


Fig. 7—Arrangement of the penstocks at the power house

level at any moment in any of the reservoirs is indicated and recorded in the power house by a Selsyn-motor operated device. Through this system a flexibility of operation is attained that otherwise would be impossible. The sluice gates at the intake to tunnel No. 1 have but two remotely operated positions—open and closed. The butterfly valves, similarly, are remotely operated to open or closed positions. Electric interlock prevents the opening of the butterfly valves until their bypass valves have been opened. The trash racks at the reservoirs, while motor powered, are not remotely operated.

This interesting development was put in operation on March 4 of this year. All the engineering work on the project was done by the Constant Angle Arch Dam Company, San Francisco, of which Lars R. Jorgensen is chief engineer. R. C. Storrie & Company were general contractors for all the construction work. Ross White was resident engineer in charge of all inspection and field engineering.

SUMMARY OF EQUIPMENT IN BUCKS CREEK DEVELOPMENT

Waterwheels, two	Pelton Water Wheel Co.
Capacity, each, hp	35,000
Speed, r.p.m.	450
Static head, ft.	2,561
Jet diameter, in.	8.05
Governors	Pelton Water Wheel Co.
Sluice and cylindrical gates	Joshua Hendy Mfg. Co.
Trash racks and rakes	Newport News Shipbuilding & Drydock Co.
Penstocks supplied by	Western Pipe & Steel Co.
The banded sections of the penstocks were manufactured by Aktiengesellshaft, Ferrum, Bogucice, Poland, and the riveted sections by the Western Pipe & Steel Company, which handled the whole contract and acted as agents for Ferrum.	
Cranes, two 50-ton	Pacific Rolling Mills Co.
Water-level indicators	Butte Electric & Mfg. Co.
Flow meters on penstocks	General Electric Co.
Generators, transformers and switchboards,	General Electric Co.
Generator air washers	Spray Engineering Co.
Power-house sash	Truscon Steel Co.
Power-house structural steel	Pacific Rolling Mills Co.

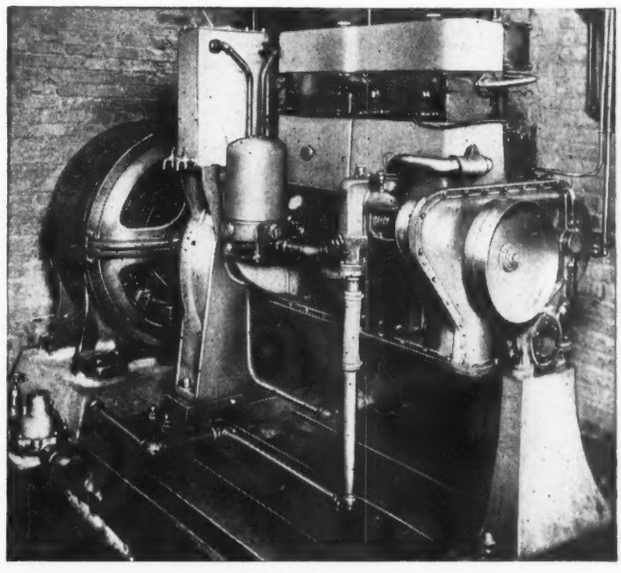
High-Speed Diesel Supplies Power for Cranes

By G. Grow

MANY factory power plants generate alternating current only and, as a result, must have some method of delivering direct current to machinery on which the use of alternating current is not advisable.

An instance of this involves the operation of overhead traveling cranes, which, if the advantages of dynamic braking are to be gained, requires a source of direct-current supply. Dynamic braking cannot be obtained with alternating-current motors, owing to the fact that they cannot be automatically reversed. In addition, direct-current motors afford a high starting torque and close speed regulation, both important considerations.

To provide a source of direct-current supply for this purpose, it is possible to install an engine-driven gen-



Buda high-speed Diesel driving a 65-kw. generator

erating set such as that shown by the illustration. This set consists of a high-speed Diesel engine direct-connected to a 65-kw. 900 r.p.m. 250-volt 260-ampere direct-current generator. The engine is of the four-stroke-cycle type, and fuel is injected without the use of an air compressor. It is provided with a self-starter, and no heating devices are required. The lower grades of fuel oil are used, and electricity can be generated at a cost as low as ½c. a kilowatt-hour for fuel and lubricating oil. The 65-kw. unit illustrated occupies a floor space of 5x10 ft.

In this particular plant power is furnished to three 5-ton cranes and one 3-ton crane in a foundry and machine shop. The 5-ton cranes are equipped with 11-hp. motors on the hoist and bridge and 3-hp. motors on the trolley. The 3-ton crane is equipped with 5-hp. motors on the hoist and bridge and a 2-hp. motor on the trolley. The cranes in the foundry operate on a 24-hour schedule six days a week, so that there is a continuous demand on the generating set, the load fluctuating from one to 300 amperes, and often increasing instantaneously from zero to full rating.

The ability of this set to provide continuous service and to withstand the wide variation in load without greatly affecting the voltage regulation testifies to the dependability of the engine and its close speed regulation.

What is being done about

Prepared Liquid Fuels*

By A. A. Potter and H. L. Solberg

Dean of Engineering, Purdue University — *Ass't Prof. of Mech. Engineering, Purdue University*

The present state of development and commercial possibilities of liquefied coal, synthetic motor fuels, colloidal fuel, alcohol and shale oil

MUCH interest has been aroused in the development, by Doctor Bergius, of Germany, of a method of converting coal into a liquid somewhat similar to petroleum. Should the claims made for this process prove true, it may have a great influence upon the fuel situation.

In bituminous coal the ratio of total carbon to total hydrogen varies from 20 to 11, with an average of about 16. In petroleum this ratio is about 8. The Bergius process consists essentially of altering the molecular structure and increasing the hydrogen content of coal until it approaches that of petroleum. Powdered coal is mixed with oil or coal tar to form a thick paste and is then pumped into a steel tube under a pressure of 1,500 to 2,200 lb. per sq.in. For each ton of coal treated, about 100 lb. of hydrogen and a similar weight of iron oxide are introduced. The mixture is then heated at high pressure to 750 or 800 deg. F. The resulting products are listed in Tabie I.

It is claimed that one ton of gas coal will produce 140 gal. of crude oil, or about 3.3 bbl. This oil can be refined to produce 40 gal. of motor fuel, 50 gal. of Diesel engine oil, 35 gal. of fuel oil, a pitch residue and 10,000 cu.ft. of gas. The process is said to work best with the poorer grades of coal. The hydrogenation of coal is in the experimental stage as yet. The chief problems involve a cheap supply of hydrogen and pressure vessels that will stand the temperatures and pressures used.

Synthetic Motor Fuels

Large-scale manufacture of synthetic ammonia by the combination under high pressure of nitrogen and hydrogen, has led to the study of the combination of hydrogen with other gases under similar conditions. Scientists in France and Germany have succeeded in producing motor fuels from blue water gas. At high pressures and temperatures and in the presence of a catalyst, the following reaction occurs:

$$CO + 2H_2 = CH_3\,OH.$$

Methanol, the resulting product, is a satisfactory substitute for gasoline. The heating value per gallon is about 60 per cent that of gasoline, but somewhat higher thermal efficiencies can be obtained in specially designed engines than is obtainable with gasoline in the conventional automobile motor. It is reported that one company in Germany is producing 20 tons of methanol per day at a cost of 16c. per gal. and that large quantities are being shipped into the United States and sold at prices below the prevailing cost of wood alcohol. In the opinion of Dr. A. C. Fieldner, when our petroleum supplies approach exhaustion, synthetic motor fuel will be made at the city gas works from blue water gas.

The synthesis of carbon monoxide and hydrogen from methanol is done at a temperature 100 to 200 deg. C. below that used in the synthesis of nitrogen and hydrogen to form ammonia, which is now a large-scale commercial success.

The working pressure is about 12,500 lb. per sq.in. The most satisfactory catalyst is a mixture of the oxides of zinc and chromium. Direct contact between the gaseous mixture and iron must be avoided at high temperatures. It is necessary to plate all iron parts of the apparatus with copper, aluminum, chromium or some other glaze which is inert to CO and H_2 at high temperatures.

TABLE I—RELATIVE YIELDS OF PRODUCTS FROM LOW-TEMPERATURE DISTILLATION AND BERGENIZATION, IN PER CENT OF DRY BITUMINOUS GAS COAL*

	Bergenization, Per Cent	Low-Temperature Distillation, Per Cent
Motor spirit	15	1.5
Diesel oil and creosote oil	15	3
Fuel oil, lubricating oil, pitch	20	4.5
Ammonia	0.5	.....
Water	8	5
Gas	20	15
Ash	10	10
Organic matter insoluble in benzine	11.5	.....
Semi-coke	.....	61
Total	100.0	100.0

*"Transformation of Coal into Oil" by Dr. Frederick Bergius, "Proceedings of Int. Bit. Coal Conference," 1926.

Colloidal Fuel and Alcohol

Colloidal fuel was developed during the World War by the Submarine Defense Association of New York in order to augment the supply of fuel oil. It is composed of an intimate mixture of fuel oil, finely powdered coal and a "fixateur" which is intended to keep the fine particles of coal in suspension. A typical fixateur consists of a lime-rosin grease composed of 83.5 per cent oil, 10 per cent rosin, 5 per cent lime and 1.5 per cent water. It is claimed that a mixture of 70 per cent oil, and 30 per cent powdered coal plus a small amount of this "fixateur" will produce a liquid fuel in which the coal will show little tendency to settle. A gel of high viscosity may be produced in the bottoms of the fuel tanks in time, but agitation or heat will restore the fuel to its original homogeneous condition.

The heat content of colloidal fuel is less than that of fuel oil, but it provides a fuel, particularly for naval

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purposes, that would be used in case of shortage of oil, without the necessity of changing any of the regular fuel storage or burning equipment of a vessel.

Alcohol offers possibilities as a fuel because it is produced from vegetation so that the supply of raw material is being continually renewed. Alcohol can be manufactured by the fermentation of such materials as corn, potatoes, "black-strap" molasses, straw, corn stalks, waste liquor from sulphite paper pulp manufacture and any other source of starchy material. From 15.4 to 22.8 gal. can be produced by the destructive distillation of a ton of wood waste such as sawdust or hogged wood. It is doubtful if alcohol can be produced cheaply from farm products. With corn at 40c. a bushel, the cost of the raw material will be 15c. per gallon of alcohol produced.[1] With potatoes at 50c. per bushel the cost of the raw material would be 67c. per gal. Although these prices are not attractive to the farmer, they are too high to permit of the manufacture of cheap alcohol. If alcohol is to be made at a reasonable cost, it must be made from waste materials. Unfortunately, that which can be made in this country from the available waste materials is not sufficient to supply 10 per cent of our present requirements for motor fuel. There remains the possibility of producing alcohol from tropical and subtropical vegetation.

TABLE II—HEATING VALUE OF ALCOHOL, BENZOL AND GASOLINE

Fuel	Approximate Higher Heating Value, B.t.u. per Lb.
Ethyl alcohol (C_2H_5OH)	12,780
Methyl alcohol (CH_3OH)	9,550
Benzol (C_6H_6)	18,000
Denatured alcohol	11,600
50 per cent mixture of alcohol and benzol	14,200
Gasoline	20,200

From "Mechanical Engineer's Handbook"—Marks.

Alcohol is a suitable fuel for internal-combustion engines if they are designed especially for it. The efficiency with which a fuel can be used in an internal-combustion engine depends upon the degree of compression. Alcohol can be used with much higher compression pressures than gasoline. The higher thermal efficiencies obtainable with alcohol in engines designed to operate on high compression pressures offsets to some extent its lower heating value. The heating values of alcohol, benzol and gasoline are given in Table II.

It is probable that alcohol will be used in blended fuel in combination with benzol and gasoline. Pure benzol freezes at about 40 deg. F., but this difficulty can be overcome by blending it with alcohol. Commercial alcohol contains some water, which prevents it from being blended with ordinary gasoline, but the addition of benzol to the mixture makes a satisfactory fuel for internal-combustion engines.

Shale Oil

Shale contains a substance called "kerogen," which consists of hydrocarbon compounds of animal or vegetal origin that break down under the influence of heat to form oil, but in its natural state the shale contains practically no oil. Oil can be obtained by destructive distillation, or heating in the absence of air, but very little can be obtained by extraction by means of the ordinary petroleum solvents. The important products obtained from destructive distillation are oil, gas and ammonium sulphate. The oil yield per ton of shale varies widely and is generally between 5 and 85 gal. per ton. The shales that will yield over 30 gal. per ton are limited, although enormous deposits of shale that will yield at least 10 gal. per ton exist in almost every country. Oil produced from shale varies with the quality of the raw shale and with the treatment. Shale differs considerably in color, structure, appearance and chemical composition. Consequently, methods of retorting that are suitable for one class of shale may not be satisfactory for another type.

The commercial development of the oil shale industry has been a success in Scotland, but has met with financial failure in other countries. The average yield of crude products obtained from one ton of crude shale in Scotland during 1919 were as follows:[2] 9,800 cu.ft. of gas having a heating value of 270 B.t.u. per cu.ft. and used as fuel at the retorts, 24.5 gal. of crude oil and 35.7 lb. of ammonium sulphate. The Scottish shale industry owes its success to the high yield of ammonium sulphate, which commands a good price as fertilizer. As American shales contain only about one-half of the recoverable nitrogen compounds found in the Scottish shales, the success of the Scottish industry does not warrant the conclusion that such an industry can be developed on a commercial basis in this country in competition with cheap petroleum. Also, the development of cheaper methods of fixation of nitrogen from the air may reduce the price of ammonium sulphate to the point that its recovery from shale will not be profitable. The gasoline content is only about 10 per cent and the refining losses are high. Of course the gasoline yield can be increased by cracking the heavier gas and fuel oils.

There are two principal deposits of oil shale in the United States. One is in the Green River formation of northwestern Colorado, northeastern Utah and southwestern Wyoming. The other is in Kentucky, southern Ohio and Indiana. It is estimated that if 60 per cent of the total shale in northwestern Colorado existing as beds 3 ft. or more thick and yielding at least 15 gal. per ton were treated in retorts, it would produce a total of 40,640,000,000 bbl. (42 gal. each) of crude shale oil.[3] This is over four times the present petroleum resources of the United States. It is estimated that 100,000,000,000 bbl. of oil can be obtained from the shale in southern Indiana, based on a yield of 10 gal. per ton and mining 15 ft. out of an assumed average depth of oil-yielding shale of 30 ft.[4] Eastern shales are leaner in oil yield than Western shales, but are more favorably situated.

Development of the oil-shale industry is still in the experimental stage in this country, but it is only a question of time until the decreasing petroleum supply and the increasing price of oil will make the manufacture of artificial petroleum from oil shale a profitable business. Much experimental work must be done in order to develop methods of retorting that will be adaptable to American shales. Trouble has been encountered in attempting to use the Scotch retorts without change in the retorting of American shales. One of the principal difficulties in the way of the development of an American shale-oil industry is the cost of mining the shale. Assuming equal mining costs and not including the cost of retorting the shale, the cost of a B.t.u. in the form of shale oil is five times that of a B.t.u. in the form of coal. It is apparent, therefore, that crude shale oil will never replace coal as a steam boiler fuel. As a source of fuel for internal-combustion engines the shale oils may replace petroleum in time.

[1] Ohio State University, Eng. Exp. Bulletin 19.

[2] U. S. Bureau of Mines, Bulletin 210, "Oil Shale."

[3] Bulletin 729, U. S. Geological Survey.

[4] Bulletin 641, U. S. Geological Survey.

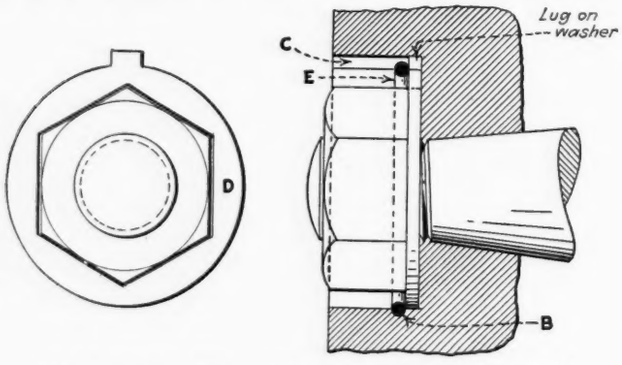
Right Out of the Plant

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

A Lock Washer for Piston-Rod Nut

WHILE overhauling a horizontal steam engine we found that the piston was loose on the rod. The nut evidently had backed off, but on account of abused threads, had stopped about $\frac{1}{16}$ in. from the piston.

When the piston was taken out for the fitting of new rings, we put it in the lathe and turned out a groove *B* as



Lock washer fits over hexagon nut on piston rod

shown in the illustration, and we also cut keyway *C* to take a lug of the lock washer to hold the nut.

The washer *L*, of $\frac{1}{8}$ in. thick sheet iron, was made and put on after the nut was tightened up on the rod. It was filed down to fit closely on the nut and in the keyway. A spring *E* was expanded in the groove to hold the washer in place. A. LEKSTROM.

Ironton, Minn.

Cements for Electrical Purposes

CEMENTS for electrical purposes should be chosen with care because of their possible action on insulation and metal. Sulphur corrodes untinned copper, therefore cements containing sulphur are best avoided for electrical work. A litharge and glycerin cement is good for fixing insulators in switchgear, but the selection of the materials and mixing should be done with care.

The materials should be free from impurities. A good method of mixing is to put some litharge on a clean slab of slate and then add dry glycerin and work the two together until a thick cream is formed. The cement is then ready for application. Roughly, equal parts of both should be used, but an exact proportion is not possible owing to the method of mixing.

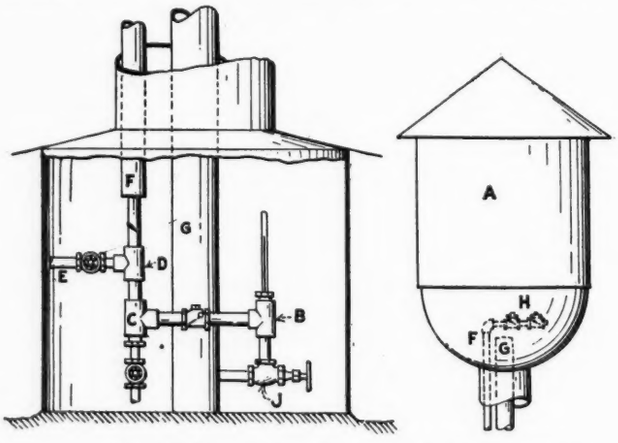
All iron parts that have to be covered with any cement should first be galvanized, zinc-plated or painted, to prevent the iron rusting after it is covered with cement.

The use of sulphur cements or cements containing sulphur for binding insulating forms of millboards, etc., should be avoided on account of the bad effect of sulphur on insulation. In one instance on a small generator the insulation of the shunt-field coils was found to be badly deteriorated. The coils were examined and found to have on them a powder resembling sulphur. The outside of the insulation of the coils was tested with the connections from a 250-volt lamp circuit. When the connections were placed three inches apart on the insulation, the lamp would light and sparks could be seen jumping across the insulation, the powdery substance forming a conducting path. The coils were taken off the machine and the wire unwound from the spools. The formers were found to have been built up from layers of millboard joined together with a cement containing sulphur. Vibration had caused the cement to loosen and disintegrate, and it had worked onto the insulation, where it caused the effects mentioned. W. E. WARNER.

Brentford, England.

Heating Tower Tanks

OFTEN trouble is experienced in keeping tower tanks and their piping from freezing. The base of the 100,000-gal. tank *A*, supported by steel framework, is 125 ft. from the ground. In the illustration the view at the left shows the house about the base of the riser *G* and the piping provided to heat the water and maintain circulation. To a 2-in. opening in the riser *G*, a water connection was made containing angle valve *J*, tee *B* with a thermometer inserted, a swing check valve and tee *C*. The lower end of tee *C* has a valved drain and the upper end connects with the circulating tee *D*. The latter receives steam through the valve *E*, and through its lower end *G* water that is forced up by the



Circulating water in tower tank by steam keeps it from freezing

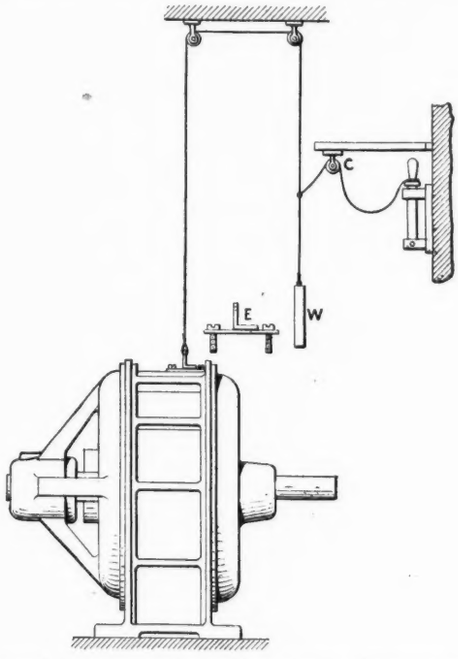
steam and discharged through check valves into the tank *A* shown at the right in smaller scale.

The circulating tee was used because its large steam opening permits more or less steam to be used, as required, to maintain the desired temperature. The condensation being added to the tank water just about takes care of the natural leakage. The check valves are used to prevent reversal of flow. The thermometer at the base of the riser is easily accessible and indicates the lowest temperature of the water. W. L. PARKER.

Elgin, Ill.

Home-Made Cutout for Three-Phase Motors

THREE-PHASE induction motors often are installed where they are seldom seen except by periodic caretakers. Some operate continuously others only at intervals. If one fuse blows, the motor will continue to run and may overheat if operating at near full load. To protect the motor against this condition, an open-



Device used to open switch when motor becomes too hot

phase relay should be used. Where such a relay was not available, the device shown in the figure was used.

This consists of two or more encased screw pulleys, a few feet of sash cord, one sash or other weight and two small strips of brass *E*. The straight piece of brass is screwed to the laminated core of the stator, and the right-angle piece is attached to it by a solder that melts at 165 deg. F. In the vertical leg of the angle a hole provides for attachment of the sash cord, which passes over two or more pulleys and has the sash weight *W* attached to the other end. Attached to the first cord is a second piece that passes over pulley *C* to the switch.

Chicago, Ill. P. L. WILLIAMS.

Pointers on Burning Coke Breeze

BURNING coke breeze under steam boilers is more or less difficult if steady steaming is desired, because the clinker will granulate and bake to the grate. The best type of grate for burning this fuel is a flat one with deep bars, having a water trough or pan directly below to lower the temperature in the ashpit. The air needed for combustion is supplied under pressure between the grate and the water trough. The air supplied in this way is moisture laden, and this assists in cooling the bars and keeps them much cooler than otherwise. The cooler air, together with the moisture entrained, helps to prevent the clinker granulating and sticking to the bars.

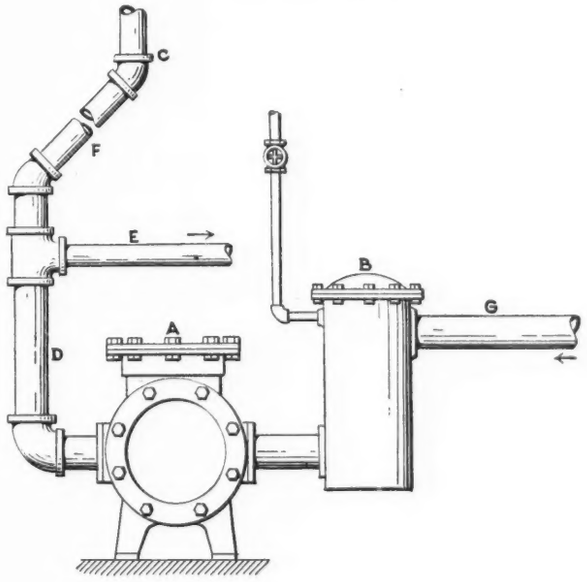
With ordinary boilers a long flat pan capable of holding from two to three inches of water can be fixed in the ashpit. Then, as the hot ashes fall into the water, steam is given off and this is carried into the fuel bed with the air. Ashes must not be allowed to accumulate in the trough or pan, which should be kept filled with water. This method enables the boiler to steam regularly and to be forced if necessary. The humid air has been found to have no bad effect on the brickwork or other parts of the boiler. W. W. EMERSON.

Birmingham, England.

Repiping a Heating System to Separate Air from Condensate

IN THE old-type Webster steam heating system illustrated, the vacuum pump handles the condensation and also the noncondensable gases, the latter being principally air that enters the system with the steam or around loose valve stems whenever the pressure within the system is less than that without. Special thermostatic valves control the discharge from the units of radiation into the return piping to the pump. Just before the pump is reached a condenser is installed in the piping. In the top of the condenser is a raw water jet used to condense the steam that gets past the thermo-valves and would interfere with the best working of the pump. The condenser also contains a strainer through which all the water must pass and which removes foreign matter that might injure the pump. The pump passes whatever it handles on toward the heater, and it is highly important to separate the air from the water before it reaches the heater. This separation is accomplished by the scheme of piping shown in the drawing.

Referring to the illustration, the returns come back through pipe *G*, pass through condenser *B* and vacuum



Inclined pipe separates air from condensation

pump *A* and are discharged through pipe *D* to enter the heater through pipe *E* and rise in the inclined pipe separator *F* to the height *C*, equivalent to the pressure on the heater.

In this inclined pipe the air bubbles rise to the upper wall, along which they move until they escape up the vertical pipe. The water passes down the lower wall of the pipe to the heater. P. W. LEWIS.

Peoria, Ill.

As the Other Fellow Sees It

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Industrial Museums Can Render Service

REFERRING to the editorial in the Sept. 18 issue on "Industrial Museums Can Render Service," the point cannot be stressed enough that industrial museums can be a great aid to American engineering.

Past endeavor is the solid foundation upon which present-day scientific and engineering practice rests. A knowledge of what has gone before is essential to present-day progress. In order that improvement may continue, it is not enough that the engineer know only of those things that exist today.

The visual aid of actual historic machines is necessary to teach the development of that machine successfully. Setting down a theory, as in a textbook, is not enough. For instance, a short inspection of a series of steam engines, from Newcomen to the modern uniflow, will teach more about how the device developed than hours of reading. Furthermore, knowledge of this nature is necessary to anyone who sets out to change or improve the engine. It will shorten his path and help him avoid mistakes made by others. Actually visualizing the subject under discussion can be best accomplished when the subject is presented through the aid of actual specimens that can be examined.

Engineers, particularly, should support the museum movement. The mental stimulus and material gain they will receive through the aid of an industrial museum will more than compensate them for any support they may lend in its establishment. HARRY KAUFMAN.

Philadelphia, Pa.

* * * *

Does the Home-Made Policy Pay in the Power Plant?

IN LOOKING over the Aug. 14 issue of *Power* I noticed an article, "Does the Home-Made Policy Pay in the Power Plant?" by C. W. Peters.

It would seem a small matter for a good mechanic to duplicate parts, and in many cases this is undoubtedly good policy and results in a saving to the owner, but a number of things should be taken into consideration which may not ordinarily be thought of by the plant engineer. One of these is the use of special materials for the purpose of obtaining additional strength or wearing qualities, and another is the matter of records. Most manufacturers keep careful records of their product, and in our own case we continue these records through the life of the equipment so far as we are able. In other words, if a cylinder is rebored or a crankpin or crank refitted, careful records of the modified bore, fits, etc., are incorporated along with the original engine record.

Within a year two cases that caused considerable expense have come to my attention. In one instance we were asked to send a crank to replace one thought to be loose, and bored it for shrinking on, on the job. After the crank was received, and fortunately before the other crank had been removed, it was found by our erecting engineer that evidently at some time during the life of the engine another crank had been shrunk on the shaft by others than ourselves, the result being that the bore of this latest crank was too large, and another crank had to be made. This would not have occurred, of course, if we had made the original repair.

The second case was that of an engine where general overhauling and replacement of parts were requested by a manufacturer who had bought the engine second-hand from others. We sent a man to inspect the engine and list the equipment needed. After the parts were delivered and installation of them started, it was found that owing to repairs previously made by others, many of the parts were not proper. The new piston rod would fit neither the piston nor crosshead, the valve rods could not be used, the new outer shells for the valves would not fit the internals, and entire new valves had to be furnished, and numerous other difficulties occurred. Delays and replacement of parts cost the owner about four or five hundred dollars more than they would have cost if the original builder had been allowed to supply needed repairs from time to time instead of job-shop owners, who do not trouble to conform to standard sizes, tapers, etc.

Fitchburg, Mass. A. A. TENNEY,
Fitchburg Steam Engine Company.

* * * *

Pinch Hitters or Regular Players

THE editorial entitled "Pinch Hitters or Regular Players," in the Sept. 25 issue deals very ably with a mistaken practice too often found in the power industry. As often as it has been quoted, it is nevertheless directly applicable to add one more to the quotation of "An ounce of prevention is worth a pound of cure." One spare machine, used as a regular player to insure the condition of the regular equipment, is really worth sixteen spares which it is hoped will function when the epidemic of breakdowns due to neglect hits the plant.

Of course, the practice of pinch hitting spares is usually justified by its proponents on the ground that the spares are old and obsolescent machines which it is not economical to operate regularly. This is a fallacy, because if the spares are not fit for regular operation, it is false economy to run the regular modern machinery to the breakdown point before overhaul is considered. The repair costs on the regular equipment are many times higher than they should be, the obsolescent machinery is uneconomical, when it does run and the chances are high that it wont run at all—so the justification for obsolescent spares is nil. With the removal of the old spares, and the substitution of modern, the last obstacle to working spares is removed. LEWIS J. YAPP.

Collingswood, N. J.

IT IS all too true that some plant engineers utilize their spare equipment as a pinch hitter, to serve in an emergency, while others make their spare equipment a regular player on the power-machinery team.

Using spare equipment regularly will allow the cleaning and overhauling of the machinery that is normally

kept in service, and this is of first importance if plant efficiency is to be kept at the proper level. Periodic inspection of all equipment should be provided for systematically, so that nothing will be overlooked, special attention being given to the points where wear is rapid or likely to cause trouble.

Using management in maintenance is one of the surest ways of keeping all equipment in a good operating condition. The purpose of keeping spare equipment will be defeated if it is only used for emergencies. When it is used to allow proper maintenance work on the machines in use, it serves its most useful purpose.

Philadelphia, Pa. ARTHUR FRUNCILLO.

* * * *

Some Hints on Second-Hand Engines

A MANUFACTURING concern in the Middle West recently decided to purchase a second-hand direct-connected engine-generator set of 200 kw. capacity. Just sixty days after this second-hand engine was installed, the flywheel (10 ft. in diameter and 20 in. face) went to pieces, doing considerable damage.

This engine, when new, had non-releasing valve gear, controlled by a shaft governor in the flywheel, which wheel also did duty running a belted generator. About 1920 the original owners decided to dispense with the belted generator. The builders of the engine were called into consultation, a new crankshaft provided, the valve gear changed from non-releasing to releasing type, dashpots, etc., attached, and a flyball governor substituted for the inertia governor in the wheel. A direct-connected generator was attached to the crankshaft, the original belt-type flywheel being retained. It ran successfully for several years more and was then sold by a dealer in engines to another corporation.

The engine was reinstalled in the main engine room of a mill where there were several other engines. The engine originally operated non-condensing, but in order to gain a little more efficiency, it was suggested to make it condensing. A second-hand horizontal condenser, circulating pump and the air pump were finally located and purchased. This outfit, all second-hand, was assembled and started up and appeared to operate successfully, but just sixty days later the flywheel went to pieces. The wheel, 10 ft. in diameter, had six spokes, 4x11 in. elliptical section, the rim having a net thickness of $2\frac{1}{4}$ in. and revolved at 165 r.p.m.

The hub of this wheel was secured to the shaft by six $2\frac{1}{4}$-in. hub bolts. The cause of the wheel's breaking was the shearing of three of these bolts through the threaded section at the base of the nuts.

When the hub-bolts were originally inserted, when the engine was new, they were, of course, heated and pulled up tight when in a heated condition, the holding and tightening effect being augmented when the bolts shrunk. Then the engine was sold and knocked down for shipment as a second-hand proposition, and when reinstalled, the same hub-bolts were used over again, and once more they went through the heating, tightening and shrinking process. This treatment crystallized the bolts, causing them to break. This view was upheld by the builders of the engine, who advocated new hub-bolts when the engine was reinstalled, but the purchasers objected to the additional expense and the old bolts were retained.

When second-hand engines (engines that change ownership and location) are reinstalled, new hub-bolts should in every case be provided, and care should be taken, when heating the bolts, that the temperature is not excessive, which may cause segregation and crystallization. It would also, in my opinion, be advisable in a case of this kind to remove the belt wheel and substitute a balance wheel of standard type.

The aforementioned wheel, 10 ft. in diameter, revolving at 165 r.p.m., had a rim speed of practically a mile a minute. Had the wheel been 8 ft. in diameter, and standard type of balance wheel, having the same weight as the belt-type wheel, or even somewhat heavier, then 210 r.p.m. would have given the same speed per second, and the factor of safety against disruption of the rim would have been 20 per cent greater.

Second-hand engines, particularly when operated condensing, with second-hand auxiliaries, made by different manufacturers and assembled together as a whole more or less haphazardly, cannot give the same effectiveness of operation as a new unit.

Cincinnati, Ohio. J. F. WHITELEY, Inspector,
The Fidelity and Casualty Co. of New York.

* * * *

Comparison of Steam Consumption by Flow Meters vs. Indicator Diagram Calculations

SOME time ago I had an opportunity to run some tests on a 17x36-in. Corliss engine, with a flow meter to measure the actual steam flow and the usual indicator diagram data.

Out of curiosity a check was made of the steam consumption figured from the indicator diagram against the flow meter, using Heck's formula (Kent) for cylinder condensation. The indicator diagram calculations were based upon conditions at cutoff.

Indicator diagram data:

Steam pressure: 157 lb. gage.
Exhaust pressure: 15.1 lb. gage.
Cutoff: 15.6 per cent of stroke.
Clearance: 0.5 per cent of stroke.
Pressure at cutoff: 132.5 lb. gage.
Indicated horsepower: 185.9.
Steam consumption per i.hp. at cutoff, calculated from diagrams: 13.8 lb.

Heck's Formula:

From Kent, page 1056, tenth edition.

$$m = \frac{C}{\sqrt[3]{N}} \sqrt{\frac{sT}{pe}}$$

Where: m is ratio of condensation to total steam;
C is constant for conditions, 0.27;
N is r.p.m., 102;
s is nominal cylinder surface divided by piston displacement, 3.48;
T is empirical function of steam pressure, 400;
e is cutoff and clearance ratio, 0.161.

The steam condensation from the foregoing data is found to be 11.3 lb. per indicated horsepower. Total steam accounted for by indicator diagrams equals 13.8 plus 11.3 or 25.1 lb. per i.hp.

Steam consumption recorded by flow meter was:

Total steam per hour: 4,670 lb.
I.hp. per hour: 185.9.
Steam per i.hp.: 25.2 lb.

Of course this check is unusual. It might even be suspicious. It was, however, interesting to me, as most of our steam consumptions are obtained by means of indicator diagrams. F. M. AHER.

Pittsburgh, Pa.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Tandem Boiler Blowoff Valve with One-Piece Forged Steel Body

A TANDEM blowoff valve designed to obviate the effect of the wiredrawing of the steam and water through the valve, and in which the two valves are incorporated in one body, has been brought out by the Cochrane Corporation, of Philadelphia. The valve assembly is shown in Fig. 1 and a section of each valve in Fig. 2.

Fig. 1—The two valves are incorporated in one body

The valve nearer the boiler is of the rotating gate type, and in ordinary operation is intended to be opened before the main valve is opened and to be closed after the main valve is closed. The gate member is conical in shape and is ordinarily held to its seat by a seating spring and by the water pressure. In order that it may be turned easily and without scratching of valve or seat, provision is made for lifting it from the seat before it can be turned.

The operating lever is locked by a projection which fits into an index plate, and before the valve can be turned the lever must be pulled back or lifted free, by which operation, through the action of a cam upon the stem of the valve, the latter is forced from its seat. The lever is then swung through 90 deg., but the valve cannot be seated until it has reached the final position, at which point a slot in the index plate permits of the lever again being pushed in. The valve member is a one-piece, stainless steel forging, hardened and ground.

The main blowdown valve, which controls the actual blowdown, has a main sealing disk *A* and a check disk *B*. The sealing disk is provided with a bypass valve *C* to equalize the pressure while the sealing disk is being opened and closed. The check disk *B* is in series with the main disk and the bypass and takes all the wear and wiredrawing of the actual opening and closing under pressure and flow. The function of the check disk *B* is merely to hold the pressure while the sealing valve *A* is being seated or unseated. The sealing disk and seat, on the other hand, are not subjected to wiredrawing, cutting or abrasion. Both the sealing valve and the check valve and their removable seats are stainless steel, hardened and ground.

The sequence of operations in opening the valve and blowing down the boiler is as follows:

First, the valve lever of the rotary gate valve is lifted, which pushes the gate valve *D* off its seat by the action of the cam, already described, upon which the gate *D* is rotated through 90 deg. to the open position, giving a straight-through passage, and then the lever is pushed in, again seating the valve. The handwheel of the main valve is next backed off sufficiently to raise the bypass valve *C*, which equalizes the pressure on the sealing disk *A*. Further backing off lifts the sealing disk away from its seat, so that it is not subjected to erosion when flow begins. Finally, complete backing off the handwheel lifts the check disk *B* away from its seat and to a position above the horizontal opening through the body and also out of the current of sludge and water discharging at high velocity from the boiler. The operation of closing the valve is performed in reverse order. The sealing disk *A*, the bypass valve *C* and the rotary valve *D* are opened and closed while in a balanced position and without throttling or wiredrawing, the wear and erosion being taken by the secondary valve or check disk *B*, the perfect tightness of which is unessential, as it acts merely to hold back the flow while the main valve is being moved.

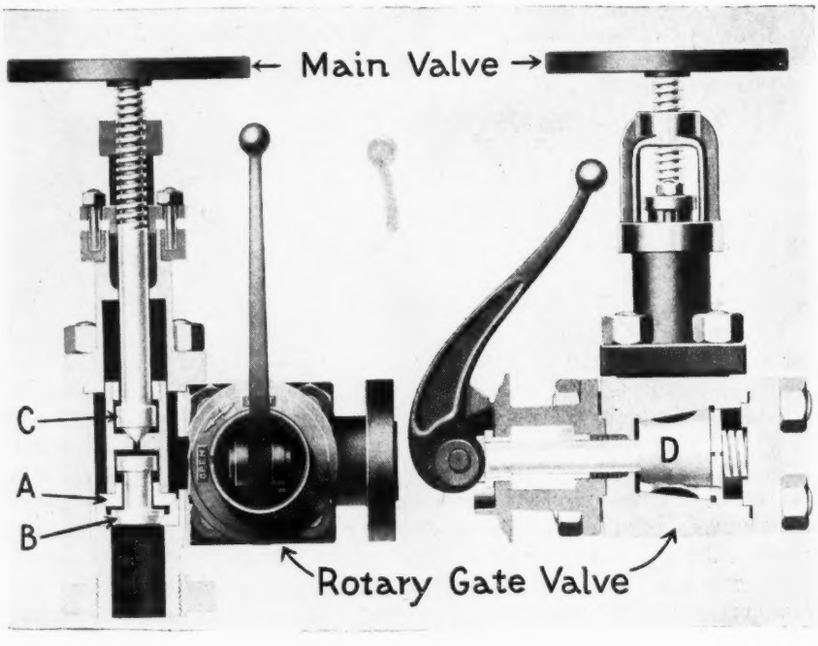
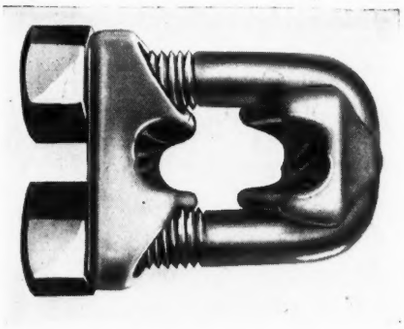


Fig. 2—Section of main and rotary valve

Cable Clip Has Two Grooved Jaws

CABLE clips with large holding surface provided by two fully grooved jaws have been put into production in a full range of sizes, of steel or bronze, by the Eureka Metal Products Corporation, of North East, Pa. By tests this new patented clip



Cable clip with two grooved jaws

has shown ability to carry three times the maximum load of the ordinary clip and is reported to give equally good results on wire rope and messenger strand.

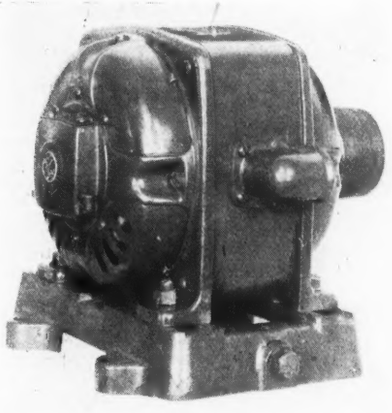
From the illustration it will be seen that the surfaces of both the top and bottom plates are grooved for the lay of the cable, so that neither of the cables is gripped by the U-bolt. Similar to the usual design, the new clip has only four parts. The construction is sturdy, and it will be seen that the extra grooved jaw is peened to the U. An important feature of the clip is that no matter how tightly the nuts are pulled down, the grooved surfaces prevent any distortion of the cable.

Improved Single-Phase Motor

THE General Electric Company, Schenectady, N. Y., announces an improved single-phase, repulsion induction motor. This motor, in sizes including ¾-, 1-, 1½- and 2-hp. at 1,800 r.p.m., supplements the present line of SCR motors. It is of the constant speed, high-starting-torque type for general application.

One of the most important improvements is the more efficient use of the stator punchings. This is accomplished by taking full advantage of the design possibilities of the polar winding of a repulsion motor, in which the number of turns in the various coils of any one pole varies according to the angle from the pole center. The new motor is a four-pole, and a square punching with graded slot depths is used, the slots being so arranged that the deep ones are placed at the corners where the maximum core is available, and with the shallow slots placed in the flat portion of the punching where the minimum core is available.

As a result of this modification the active core section is unusually large, permitting a design of low flux density and larger bore. A modification has also been made in the commutator and brush rigging design, so that the commutator end shield have the same dimensions as the pulley end shield, thus giving the machine a symmetrical appearance. The motor is equipped with phosphor-bronze



Motor with base and pulley

waste-packed bearings of the same size at both ends.

The motor is inclosed except for ventilating openings in the lower portion of each end shield. Air is drawn through the ventilating openings at the pulley end by means of an internal fan, passes around the stator laminations and out through the ventilating openings in the commutator end. This construction makes a practically inclosed motor and provides complete protection against falling particles and splashing water. In spite of this and the small size of the motor, it is designed to operate within a temperature rise of 40 deg. C. This materially broadens the field of application, permitting the use of a standard 40-deg. motor in many cases where only a larger, closed machine would otherwise be used. With only a slight change in the inclosing features the motor may be made of the totally inclosed type, somewhat reducing the rating.

Improved Skip-Hoist Winding Machine

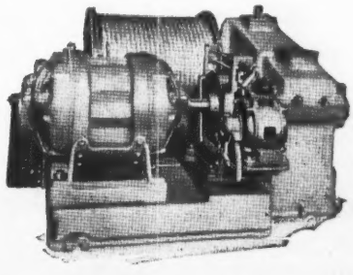
THE R. H. Beaumont Company, Philadelphia, Pa., has recently brought out the spur-gear type winding machine illustrated.

The machine is especially designed for heavy continuous service. The winding drum is connected to the motor by a chain of spur gears totally inclosed and running in an oil bath. As no worm gears or thrust bearings are used and all bearings are roller type, the friction is reduced to a minimum.

The design of the unit provides for direct and positive control of the skip buckets at all times without the use of track limit switches. The machine is fitted with a shoe-type magnetic brake, complete controlling equipment and slack cable switch.

In operation, with full automatic, full magnetic control, the operator pushes a starting button, causing the skip bucket to ascend, dump, reverse, descend to the loading pit, where it is automatically filled, and again ascend, continuing through this cycle until the stop button is pushed.

With semi-automatic, full magnetic control, as generally used for ash-handling service, the bucket will come to rest in the pit automatically at the end of each trip. When both coal



Winding machine with spur-gear drive between motor and drum

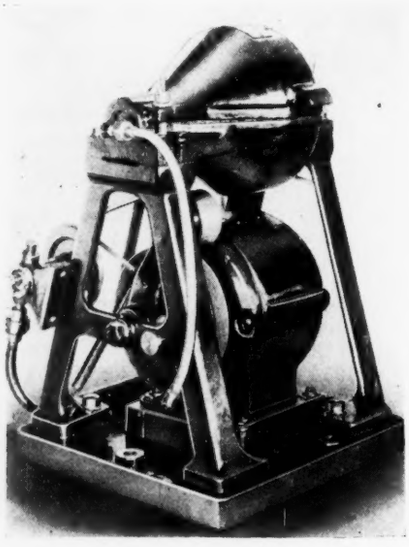
and ashes are handled by the same skip hoist, these two types of control are combined, so that coal may be handled continuously and ashes intermittently.

Other features of the machine are as follows: Hoist drum with machine-turned grooves; flexible couplings between motor and spur-gear drive; control equipped with overload and no voltage release; slack cable device to throw off motor if cables become slack.

Small-Capacity Oil Clarifier

A SMALL oil clarifier suitable for use with high-pressure compression equipment and Diesel engines, has been added to the line of oil clarifiers put out by the De Laval Separator Company, 165 Broadway, New York.

The new unit is known as the 17-H machine and is rated at 17 to 18 g.p.h. It consists of a base upon which is mounted a small motor, belt connected to a horizontal bowl of the usual De Laval disk construction.



Horizontal oil clarifier

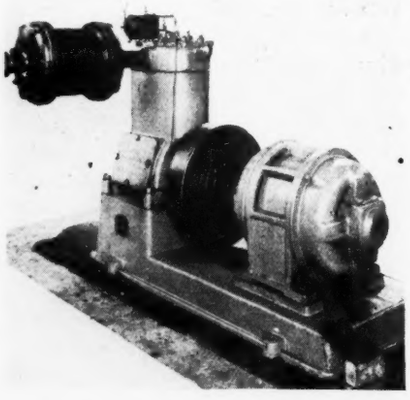
Water and dirt removed from the oil are retained in the bowl, which ordinarily requires cleaning two or three times a week. A small gear pump mounted on the unit and connected to the same motor controls the oil circulation from the lubricating system of the compressor or engine running with the clarifier.

Air-Compressor Discharge Silencer

A NEW type of silencer designed especially for use on the discharge of small high-speed air compressors, is being brought out by the Maxim Silencer Company, Hartford, Conn.

The new silencer, which is designated as model D, is designed to eliminate the discharge noise, which has the character of a hammering or rapping sound, and prevent the transmission of the sound along the discharge pipe to the receiver. Connection to and from the silencer is made by means of standard pipe threads in the center of each head. The casing is designed for 125 lb. per sq.in. working pressure.

It is claimed by the manufacturer that use of this silencer will permit the installation of small high-speed compressors in locations where quiet operation is essential, such as in schools, hospitals and similar buildings.



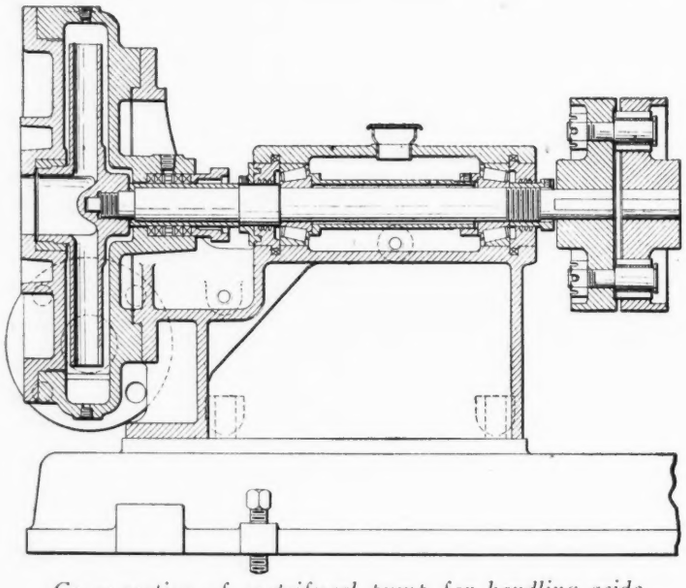
Silencer on discharge of high-speed compressor

Pumps of Special Metals for Handling Acids

THE Lecourtenay Company, Newark, N. J., has recently added to its line of pumps the type S centrifugal pump illustrated, designed especially for the chemical industries.

The unit is designed for heavy duty and the impeller has large clearances to prevent clogging. The alloy-steel shaft, which is of liberal diameter, is entirely protected from the liquids handled. The shaft is carried on double tapered roller bearings designed to take both the radial and thrust loads.

Pump casings of cast iron, lead, steel, bronze, Duraloy, Alcumite and other special metals are available to suit the different acids handled.



Cross-section of centrifugal pump for handling acids

New Cast Pipe with Outside Dimensions of Wrought Pipe

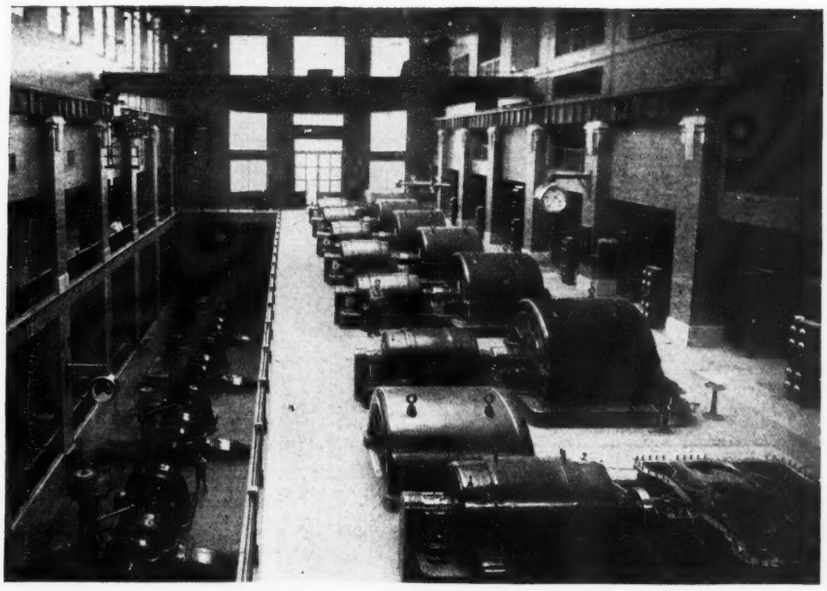
WALWORTH COMPANY, 51 East Forty-second St., New York, announces a new cast-iron pipe made of a high-quality cast-iron having corrosion-resistant properties. It is made with the same outside diameter as wrought pipe. This makes it possible to cut it at any point within its length and thread it. The standard pipe cutting and threading tools are used.

The pipe is useful wherever corrosion is present, either due to fluids being handled, or to outside soil or immersion conditions.

The company also offers fittings made of the same corrosion-resistant iron in any screwed or flanged cast-iron patterns. The use of screwed fittings of the usual types makes it possible to work in much closer quarters than has been possible with the conventional types of bell and spigot fittings. Sizes 8-in. and smaller are now available.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE



Pump room, Chicago sewage disposal plant

Chicago Opens World's Largest Sewage Disposal Plant

Battery of Motor-Driven Hydraulic and Air Pumps Are Operated on Outside Power

ON OCT. 3, the City of Chicago placed in service the world's largest activated sludge plant. Built as a part of the extensive system of the Sanitary District of Chicago, this plant comprises preliminary settling tanks, aërating tanks and final settling tanks, the entire works covering an area of 97 acres. In brief the plan is to handle mainly domestic sewage from an area of 78 square miles including the northern section of Chicago, the City of Evanston and several small towns. That part of the works which can be extended readily is designed for the city's estimated population in 1930, with an average sewage flow of 175 million gallons a day and a maximum flow 50 per cent in excess of the average. Parts of the works that cannot be extended readily are designed for 1960 conditions.

From a mechanical point of view this sewage disposal works is of interest, as it contains an exceptionally large pumping station and blower house and comprehensive air-conditioning equipment. Power will be supplied from the Lockport power house of the district at 12,000 volts and from two 33,000-volt lines of the Public Service Company of Northern Illinois. The large pumps and the blowers are driven by 6,600-volt synchronous motors. Throughout the plant liberal use has been made of meters, remote control and motor-operated gate valves.

In the main pumping station are five pumps for lifting the sewage from the north side intercepting sewer to the plant, and space is reserved for a future unit. The pumps are of the single-inlet, double-suction, horizontal, centrifugal type directly connected to synchronous motors and pumping against a total dynamic head of 44 ft. Two 48-in. pumps, driven by 1,000-hp. motors each, have a capacity of 150 cu.ft. per sec. and three units with 48-in. suction and 42-in. discharge, driven by 700-hp. motors, have a capacity of 100 cu.ft. per second each.

In a wing of the main building there are seven return and waste sludge pumps. Four sludge pumping units, one for each battery of tanks and one a spare, are provided to return the sludge from the final settling tanks to the conduits feeding the aëration tank batteries. Each of these pumps has a 30-in. suction and 24-in. discharge and a capacity, depending upon the head and speed, ranging from 5,400 to 13,500 gal. per min. The drive in each case is a 50-hp. 440-volt, variable-speed induction motor regulated by a remote-operated liquid controller.

Three waste-sludge pumps transfer the excess activated sludge and the preliminary settling tank sludge to the west side sewage treatment works for digestion. Each unit consists of a horizontal, single-suction centrifugal pump with a rated capacity of 1,000 gal. per min. against a total dynamic head of 180 ft. and a dynamic suction head of 8 ft. Squirrel-cage motors of 100-hp. rating, taking three-phase 60-cycle current at 440 volts and revolving at 1,765 r.p.m., drive these pumps.

To supply the water for conditioning the air and also for cooling the air for ventilating the motors of the blower units, there are four single-stage pumps, each having a rated capacity of 2,250 gal. per min. against a total dynamic head of 155 ft., and directly driven by a 125-hp., 6,600-volt three-phase 60-cycle induction motor.

Seven turbine blowers, driven at 3,600 r.p.m. by direct-connected synchronous motors, compress the air for aërating the sewage. The blowers are designed to operate at a rated pressure of 7.75 lb. per sq.in. gage, with air at 85 deg. F. Three of the units, driven by 1,650-hp. motors, have a rated capacity of 30,000 cu.ft. of free air per minute each and the other four, driven by 2,150-hp. motors, deliver 40,000 cu.ft. of free air per minute each. An interior view of the pump and blower house is shown in the accompanying illustration.

Air-conditioning equipment is arranged in eight units consisting of vento-type heaters, water air washers and oil-coated air filters. Each unit has 1,512 sq.ft. of heating surface arranged in two tiers, double-decked. For each unit the air washers consist of two banks of spray nozzles, one bank of scrubbing nozzles and one set of distributor and eliminator plates. The oil-coated air filter for each unit has 56 cells, 20x20 in. and approximately 4 in. deep, arranged in one bank. The air-conditioning plant has a total capacity to handle approximately 350,000 cu.ft. of air per minute.

Judge Modifies Injunction Against Fairbanks-Morse

Injunctions granted on petition of the Texas Power & Light Company restraing the Fairbanks-Morse Company, makers of power and light machinery, were modified recently by Federal District Judge William H. Atwell to permit the Fairbanks-Morse Company to sell its products in counties in Texas where the Texas Power & Light Company claimed a virtual monopoly.

Temporary injunctions had been obtained by the utility company against

the sale by the Fairbanks-Morse Company of power and light machinery to the municipalities of Commerce, Hunt County, and of Seymour, Baylor County. Franchises held by the Texas Power & Light Company were claimed as monopolies which they had a right to maintain.

The injunctions obtained kept the Fairbanks-Morse Company from selling or even soliciting the sale of power and light machinery in the state. The effect of this, they claimed, would have been to force them out of business in Texas, where they do a business of from $5,000,000 to $10,000,000 annually.

In modifying the injunction, Judge Atwell pointed out that the Fairbanks-Morse Company had a right to sell its product anywhere in the state so long as it did not engage in what is termed "unfair competition," the spread of disparaging comment concerning a competitor's product.

Paugan Development Takes Its Place Among Largest Hydro Plants in America

Airplane view of the Gatineau Power Company's new plant at Paugan, Quebec

ONE of the largest hydro-electric power plants on the North American continent came into operation on Oct. 1, when the Paugan, Quebec, station of the Gatineau Power Company, a subsidiary of the International Paper Company, began delivery of 80,000 hp. of electric energy to the Hydro-Electric Power Commission of Ontario. The power is transmitted over a 220,000-volt transmission line 260 miles long, and will be distributed by the commission in the Toronto area to supplement the power now supplied from Niagara Falls.

The opening of the Paugan plant with an initial installation of 204,000 hp., marks the completion of the first stage in the development of the power resources of the Gatineau River by Gatineau Power Company. Two other power houses on the river, with a capacity of 232,000-hp. installed and in process of installation, have been in operation a year, making a total of 436,000 hp. in the three plants. Above the plants a storage dam has been built, creating one of the largest artificial storage reservoirs in the world. It is believed that this is the first time in history that the water powers of as large a river have been developed on such a scale in so short a length of time.

Located on the Gatineau River, 35 miles north of the City of Ottawa, Canada, the Paugan plant is designed for 272,000 hp. to be delivered by eight generators of 34,000-hp. each, of which six are installed and in operation at the present time. The power house is 484 ft. long, 110 ft. wide, and 120 ft. high.

The dam at Paugan backs the river up a distance of thirty miles, submerging nine falls and rapids and creating a maximum head of 140 ft. Including bulkheads, the main dam is 917 ft. long and its maximum height is 150 ft. The east sluice dam has a length of 570 ft., including bulkheads, and its maximum height is 50 feet.

Twenty-six miles below Paugan is the new Chelsea hydro-electric plant of Gatineau Power Company, and a mile below Chelsea the Farmers station has been in operation for a year. Of a combined designed capacity of 290,000 hp., these two plants have installed or in process of installation, generators aggregating 232,000 hp., and part of this power goes to the new Gatineau newsprint paper mill of the Canadian International Paper Company, a few miles away.

With the operation of the three developments—Farmers, Chelsea, and Paugan—combined into a single system, the Gatineau Power Company is utilizing to the best advantage the total fall in the Gatineau River for a distance of 62 miles from its mouth and is developing about two-thirds of the available head on the whole river.

The contract under which the Paugan station is delivering electric energy to the Hydro-Electric Power Commission of Ontario is one of two which Gatineau Power Company has with the commission, and is among the largest power contracts ever signed. It runs for thirty years and calls for annually increasing quantities of power until Oct. 1, 1931, when the fixed maximum demand will be 260,000 hp. and the total yearly kilowatt-hours to be delivered approximately 1,190,000,000, which rate will then continue throughout the life of the contract.

Under the second contract, an additional 100,000 hp. is reserved for the commission, which agrees to take at least 60,000 hp. This power is to be taken in minimum annual increments of 6,000 hp. for ten years beginning Oct. 1. The commission will take the remainder of the 100,000 hp. during the ten years as far as needed.

In addition to the contracts with the commission, Gatineau Power Company has contracts for electric power with the City of Ottawa, Canada Cement Company, Ltd., E. B. Eddy Company, Ottawa Electric Company, Gatineau Electric Light Company, Ltd., and with Canadian International Paper Company for use in its Gatineau newsprint paper mill and Kipawa and Hawkesbury bleached sulphite pulp mills.

Texas Station of 15,000-kw. Completed in Six Months

The Lake Pauline generating station near Quanah, Texas, has been put into operation by the West Texas Utilities Company just six months after ground was broken and construction began.

This is considered as a time record in engineering circles, inasmuch as the 200 workmen employed on the job labored only during daylight and without requiring overtime.

The station has a capacity of 15,000 kw.; it generates at 13,200 volts and transmits at 66,000 volts; and is equipped with a General Electric turbine and three 10,000-sq.ft. Stirling boilers. The turbine is of the latest design and will operate on 375-lb. steam pressure and a steam temperature of 684 deg. The boilers are designed to operate at 300 per cent rating.

Oil and gas will be used for fuel, all equipment having been purchased with this in view. It can be converted to the use of pulverized coal should such a change become necessary.

London Fuel Conference Hears Many Important Papers

(Special Cable from H. W. Brooks, Power's Representative at the Conference)

Fifteen hundred delegates representing 8 countries presented 170 papers before the World Power Fuel Conference, London, during its session from Sept. 24 to Oct. 6, making this meeting the largest of its kind ever held. Pulverized fuel, internal-combustion engines, high- and low-temperature carbonization and utilization of fuels for steam generation were the principal topics discussed. Rosencrant, Kreisinger and others presented papers on the present status of stationary pulverized-fuel design and application in England and America. A description was given of the new Hirotani impact pulverizer recently developed in Japan. Within three years, it was stated, the Russian government will have 394,000 kw. operating in pulverized-fuel stations, the largest single installation being at Shterov. This station has a rating of 180,000 kw. and burns anthracite culm. Russian brown coal is the other principal fuel employed for pulverized-fired plants, it was stated. In Czechoslovakia a boiler efficiency of 84 per cent has been realized with Russian lignite at Mydlovary Station.

News of the American marine pulverized-fuel success on the S.S. "Mercer" was received with intense interest by European Shipping Nations at the Conference. The British government shortly anticipates appropriating 100,000 pounds sterling for further research in pulverized-fuel plants for marine purposes. Two British ships are already so equipped and a third is now under construction. Mechanical stoking at sea is also making marked progress it was said.

Germany has built experimental powdered-coal locomotives which have already operated for five months on brown coal, and has ordered two more. It is stated that a heat release of 200,000 B.t.u. per cu.ft. in these locomotives has been successfully accomplished.

The internal-combustion engine section was principally concerned with present and probable future design trends for heavy oils, which must be increasingly used in future. Higher speeds seem probable, Heldrallye engine being cited as a recent successful example. Germany contributed interesting tests on Diesel engines fitted with exhaust turbine driven superchargers of the type used on aircraft during the War. The maximum load recorded corresponds to a brake mean pressure of 133 lb. per sq.in., obtained with a supercharge of about 7 lb. per sq.in., and with the turbine running at about 6,000 r.p.m.

Low-temperature carbonization of brown coals has been practiced with economic success in Germany for nearly eight years, and several large central stations now employ it in connection with steam-generated power. England now has sixteen commercial plants each carbonizing over ten tons daily, but commercial success is not yet entirely established there, principally on account of the poor market for tar oils. One of the English plants using the low temperature carbonization process shows a profit of over three shillings per ton due to the preprocessing of the coal. It is understood that the patents on this system have been purchased there by the British Babcock Wilcox Company.

A resolution was passed suggesting that international studies be inaugurated by qualified technical organizations on steam-table research and standardization of pulverized-fuel testing and nomenclature.

A full length article on the London Fuel Conference will appear shortly in *Power*.

Seventeenth Annual Safety Congress Demonstrates Real Enthusiasm

Many Subjects of Interest to Power Men Discussed—Safety the Result of Intelligence, Not Luck, the Thought

WITH a show of enthusiasm never before approached in the safety field, upward of 8,000 delegates and interested persons generally, crowded the sessions of the Seventeenth Annual Safety Congress, just closed in New York City. The public rooms of five of the city's leading hotels were appropriated, as sessions of a general and technical nature were devoted to every aspect of safety in almost every field of human endeavor. Not only were the subjects chosen of importance and wide interest, but the men selected as speakers and lecturers were leaders in their many fields.

Readers of *Power* will be interested in the significant number of safety talks given on power and constructional subjects. Unfortunately, space here will limit a résumé of these to the smallest mention. The first paper of special interest was "The Electric Light and Power Industry—Its Contribution to the Safety Movement." This paper was prepared by John W. Lieb, vice-president and general manager of the New York Edison Company, and in Mr. Lieb's absence was presented by Colonel Jackson, of that company. Mr. Lieb pointed out that the greatest single step in the direction of safety was taken when Thomas A. Edison invented a practical electric incandescent lamp, making possible the introduction of safe lighting units in the workshop and the home. The further extension of electric light and power has contributed greatly to the safety of industrial work by making it possible to substitute electrical power for human brawn.

According to Mr. Lieb the electric companies of the United States have accepted the moral obligation to do everything possible within the companies and within the industry to prevent accidents and to assure the safety of life and limb of its employees.

To this end the electric power companies have instituted safety methods and have installed many interlocks and safety devices in order that the modern power plant may be a safe place to work in. In addition they have gone outside of their plants and have been instrumental in the development of safe practice codes for electrical installations which, if followed carefully, may be depended upon largely to eliminate hazards and prevent accidents in the nature of electric burns or shocks.

Mr. Lieb claimed that the electric light and power industry has been a pioneer in the safety movement, a leader in the introduction of safety devices, protective devices, and the promotion of effective company safety organizations.

The next meeting of interest to power men was one held in the refrigeration field, a new comer to the cause of safety. An afternoon session was devoted to an outline of what had been achieved in other lines and the advantages that would be obtained if the refrigeration industry embarked on a well-defined safety movement.

The first speaker, Charles B. Scott, Bureau of Safety, Midwest Utilities, stated that his company, engaged in the electric light business, had spent much time and money in safety work. He felt that the reason the refrigeration industry was slow to embark upon this work was that the executives did not know that the hazards existed. Most would claim that ice making was not hazardous, he said, but statistics prove that accidents are greater even than in the electric light business. For example, the ratio for serious injuries in the public utility field is 3.22 per 1,000 hours worked, while in the ice business it is 3.59 and for all industry it is but 1.76.

Disregarding the humanitarianism involved, Mr. Scott declared that safety work returned dividends in the reduction in accident losses and in more efficient operation.

A practical outline of a plant safety program was given by Vincent Wakefield, City Ice Company, Kansas City, Mo. He suggested that plant supervisors be formed into a safety committee and at the same time the workmen be induced to form their own committees.

On the third day of the Congress an interesting illustrated lecture was given to members of the Construction Section by F. E. Cudworth, resident engineer on the vast new project for bridging the Hudson River at New York City. Mr. Cudworth permitted his slides to carry the burden of his message, and with their aid he demonstrated the hazards and safety measures used in the construction of the New York Edison Company's East River plant. Here, he said, the accident record was unusually low, since the employees, who numbered up to 3,000, were constantly instructed by bulletin in the precautions necessary on structural work. One of the principal problems, Mr. Cudworth said, was the proper erection and maintenance of scaffolds, which were needed in large numbers within and without the building.

Ninety-eight per cent of the industrial accidents occurring in the United States are preventable. This statement was made by H. W. Heinrich, of the Travelers Insurance Company, at a special session for industrial engineers and executives held on Oct. 3. Preventable accidents, he declared, cost industry approximately five billion dollars yearly.

The greatest obstacle to safety progress, according to the next speaker, L. A. DeBlois, of the National Bureau of Casualty and Insurance Underwriters, is the feeling most people have that accidents are a matter of luck or fate and largely beyond human control. The average man can never picture himself as the victim of an accident. For this reason the appeal to self-preservation in safety education is generally less effective than the call to protect fellow workers.

Safety and production are closely related, according to A. W. Berresford, president of the American Engineering Council. Safety becomes effective in any plant, he insisted, when the safety idea dominates the mind and feelings of the manager. For he then builds all his organization, plant and staff, to that end.

The byproducts of the safety movement have been as important as the direct results, according to Joseph M. Larkin, assistant to the president, Bethlehem Steel Company. In working, actively for safety, the employer has, almost unconsciously, hit upon the one subject in which there is the greatest mutuality of interest between employer and employee and the least opportunity for friction.

OBITUARY

GEORGE C. WEBBER, assistant sales manager of the American Engineering Company, died at his home in Philadelphia, Pa., Oct. 1. Mr. Webber, who was born in Milton, N. H., 37 years ago, had been associated with the American Engineering Company and its predecessor, the American Ship Windlass Company, for more than seventeen years, having entered the employ of the latter company in Providence, R. I., in 1911.

ISAAC KRALL, for many years associated with Thomas A. Edison, died at his home in Clinton, N. J., Sept. 29. Mr. Krall was 85 years old and the oldest member of the gathering of Edison's early associates known as the Edison Pioneers. In his youth he fought in the Civil War, and among the major engagements in which he participated was the Battle of Gettysburg.

In 1889 Mr. Krall joined the Edison company in New York City and became chief engineer of the old Pearl Street station—the pioneer central station in the United States. He remained in this position until he purchased and became director of the Perry Mill in Clinton, N. J.

Coming Conventions

American Institute of Electrical Engineers, annual winter convention, New York City, Jan. 28-Feb. 1; annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Society of Refrigerating Engineers, at New York City, Dec. 2-6, 1928. David S. Fiske, secretary, 37 West 39th St., New York City.

American Refractories Institute, fall meeting, New York City, Oct. 24, D. A. Texter, secretary, 2202 Oliver Building, Pittsburgh, Pa.

American Welding Society, fall meeting at Philadelphia, Pa., Oct. 8-12; M. M. Kelly, secretary, 29 West 39th St., New York City.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Blvd., Chicago.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

BUSINESS NOTES

THE SPRAY ENGINEERING COMPANY, formerly of 60 High St., Boston, Mass., has moved its offices to its factory building. The future address will be 114 Central St., Somerville, Mass.

THE ATLAS CONVEYOR COMPANY, INCORPORATED, of 20 South 15th St., Philadelphia, Pa., announces that Mr. A. J. Forschner, who joined the company in July as vice-president, has also taken over the duties of secretary.

ADOLPH G. SYSKA and J. H. HENNESSY, formerly with C. R. Place, consulting engineer, announce the organization of the firm of Syska & Hennessy with offices in the Graybar Building, New York City. The new firm will specialize in the design of mechanical equipment for buildings and boiler plants.

THE FALKE CORPORATION, Milwaukee, Wis., has appointed B. W. Rogers, 225 Central Savings and Trust Building, Akron, Ohio, as its representative for Akron and environs. Mr. Rogers' previous connections were with the B. F. Goodrich Company and with the Allis-Chalmers Company.

THE STRATTON FURNACE COMPANY announces that J. W. Himmelsbach, formerly Chicago representative for the Furnace Engineering Company, has been appointed district sales manager.

C. A. DUNHAM COMPANY, 450 East Ohio St., Chicago, Ill., announces the establishment of a European branch at 18 St. Thomas St., London, England. The company abroad will be incorporated under the name of C. A. Dunham Company, Ltd.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.30@$2.50
Kanawha	Columbus	1.25@ 1.60
Smokeless	Cincinnati	1.75@ 2.25
Smokeless	Chicago	1.75@ 2.25
S. E. Kentucky	Chicago	1.50@ 1.75
Steam	Pittsburgh	1.40@ 1.90
Gas Slack	Pittsburgh	1.15@ 1.25
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00
Barley	New York	1.35@ 1.75

FUEL OIL

New York—Oct. 4, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 6¾c. per gal.

St. Louis—Sept. 26, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.346 per bbl. or 42 gal.; 26@28 deg., $1.396 per bbl.; 28@30 deg., $1.446 per bbl.; 30@32 deg., $1.496 per bbl.; 32@36 deg., gas oil, 4.151c. per gal.; 38@40 deg., 5.23c. per gal.

Pittsburgh—Oct. 1, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5¼c. per gal.

Philadelphia—Oct. 1, 26@30 deg., $1.89@$1.96 per bbl. or 42 gal.; 13@19 deg., $0.95@$1.02 per bbl.; 22 plus. $1.43@$1.50 per bbl.; 27@30 deg., $2.00@$2.07 per bbl.

Cincinnati—Oct. 1, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Oct. 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 57½@ 60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 95c. per bbl.

Boston—Oct. 1, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.45c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Sept. 29, f.o.b. local refinery, 26@30 deg., $1.15 per bbl. or 42 gallons

PERSONALS

WALTER E. LONG, vice-president and controller of The Philadelphia Electric Company, has been elected vice-president in charge of accounting of the United Gas Improvement Company.

M. A. LASSEN, mechanical engineer and expert in refrigeration engineering, has accepted a position as chief engineer for the Electro-Kold corporation in the Pacific Coast territory. Mr. Lassen has been chief engineer and consulting engineer for Copeland, Servel & Nizer. For a number of years he was assistant chief engineer for the Continental Motors Corporation, of Detroit, and later became affiliated with the Frigidaire Corporation, of Dayton, Ohio.

SPENCER S. SWASEY, of Chicago, has joined the Walter A. Zelnicker Supply Company, of St. Louis, as manager of the Equipment Department. Mr. Swasey was for twelve years with the Geo. D. Whitcomb Company (manufacturing Whitcomb locomotives), the last six of which he was in charge of sales.

TRADE CATALOGS

COAL-HANDLING EQUIPMENT — The Cleveland Crane & Engineering Company, Wickliffe, Ohio, has issued a four-page leaflet illustrating various uses of the Cleveland tramrail for coal handling and other purposes.

CONCRETE TREATMENT — The Celite Products Company, Los Angeles, Calif., has issued an eight-page bulletin describing the use of its product, "Celite," in improving the workability and other properties of concrete mixes in all forms of construction work.

PULVERIZERS—The Jeffrey Manufacturing Company, Columbus, Ohio, has just issued catalog No. 450, a publication of 32 pages describing and illustrating in great detail their swing-hammer pulverizers. The catalog contains numerous tables, dimension diagrams, and layouts intended to help in the selection of the most suitable equipment for any application.

GAS METERS—Bulletin No. 35, just issued by the Bailey Meter Company, Cleveland, Ohio, describes a number of different types of meters for the measurement of gases of all kinds, oxygen, acetylene, air, etc. The principle upon which these meters operate is clearly shown by numerous cross-sectional and cut-away views.

AIR COMPRESSORS — The Chicago Pneumatic Tool Company has issued a bulletin, No. 700, describing its duplex air compressors. This bulletin covers 24 pages and contains many tables and illustrations.

DEEPWELL PUMPS—The Byron-Jackson Pump Company, Berkeley, Calif., has recently issued Bulletin No. 283 covering the subject of deepwell pumps. The bulletin contains information of interest to all who are concerned with pumping water from great depths for irrigation and other purposes. The publication contains 24 pages and is profusely illustrated.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ill., Chicago—A. S. Alschuler Inc., 28 East Jackson Blvd., Archt., will receive bids until Oct. 15 for the superstructure of a 19 story office and stores building, etc., at Wabash Ave. and Harrison St. for Harry W. Rubloff, 10 South La Salle St. Bids on mechanical trades later.

Ill., Chicago — Leichenko & Esser, 38 South Dearborn St., Archts., will receive bids about Oct. 25 for the construction of a 21 story apartment building at 1640 East 50th St. for One Thousand Six Hundred Forty East 50th St. Building Corp., c/o architects Estimated cost $1,500,000.

Ill., Chicago—P. F. Olsen, 720 Cass St., Archt., will receive bids about Oct. 8 for the construction of a 5 story apartment building including central refrigeration plant, elevators, etc. at 69th St. and Clyde Ave. for C. Anderson, c/o architect.

Ill., Chicago—Peter F. Reynolds, 38 South Dearborn St., is having plans prepared for a 25 story apartment and stores building including mechanical refrigeration system, etc., at Clark St. and Lincoln Park W. Estimated cost $3,000,000. McNally & Quinn, 10 South La Salle St., are architects.

Ill., Evergreen Park—Little Company of Mary, 4130 Indiana Ave., is having sketches made for the construction of a 5 story hospital at 93rd St. and California Ave. Estimated cost $1,000,000. J. W. McCarthy, 139 North Clark St., is architect.

Ia., Cedar Rapids—City plans an election Nov. 4 to vote $640,000 bonds for the construction of a waterworks plant including filtration plant, pumping station, etc., electrically operated. Alvord, Burdick & Howson, 8 South Dearborn St., Chicago, Ill., are consulting engineers.

Mass., Cambridge (Boston P. O.)—Beck Hall Realty Trust, c/o Blackhall, Clapp & Whittemore, 31 West St., Boston, Archts., is having preliminary sketches made for the construction of an apartment and office building at 1201 Massachusetts Ave., here. Estimated cost $2,000,000.

Mass., East Milton (Boston P. O.)—Sewage Dept., awarded contract for the construction of a pumping station on Libby Rd., to Cross & Roberts, Inc., Statler Bldg., Boston.

Mass., Hudson—Dept. of Light & Power, L. D. Wood, Mgr., will build addition to power house including pumps, Diesel engines, etc. on Cherry St. Private plans. Work will be done by separate contracts.

Mass., Watertown (Boston P. O.) — Edison Electric Illuminating Co., 39 Boylston St., Boston, awarded contract for the construction of an electric sub-station on Spring St., here. Private plans.

Mich., Detroit—Dept. of Water Supply, will receive bids until Oct. 10, for excavation for power structures for Springwells pumping station. G. H. Fenkell, Water Board Bldg., is engineer.

Mich., Detroit—Times Publishing Co., 313 Bagley Ave., is having plans prepared for a 6 story publishing plant including steam heating and ventilation systems, boilers, elevators, etc., at West Park Pl. and Bagley St. Estimated cost $1,000,000. A. Kahn, 1000 Marquete Bldg., is architect.

Mich., Ferndale—Steel & Tubes Co., 232 East 131st St., Cleveland, O., is having plans prepared for the construction of a 50 x 50 ft. power plant and outdoor substation on Wanda Ave. here. Sessions Engineering Co., General Motors Bldg., Detroit, is engineer.

Minn., Minneapolis — Biglow Building Co., c/o W. G. Hodgson, 649 Security Bldg., awarded contract for a 12 story office building at 4th St. and 2nd Ave. to S. Wells Bros. Construction Co., 53 West Jackson Blvd., Chicago, Ill. Estimated cost $1,000,000. Steam heating system, elevators, etc. will be installed.

Miss., Starkville—W. C. Trotter, Secy. of Building Commission, State Capitol Bldg., Jackson, will receive bids until Oct. 11, for waterworks improvements including deep well, pump house, etc. for Agricultural & Mechanical College, here.

Mo., Kansas City—C. H. Getchell, 718 Bryant Bldg., awarded contract for the construction of a 16 story office building at 11th and Grand Sts., to Fridstein & Co., 111 West Washington St., Chicago, Ill. Estimated cost $1,500,000.

Mo., Kirksville—City plans the construction of a power plant. Black & Veatch, 700 Mutual Bldg., Kansas City, are engineers.

N. J., Jersey City—Greater N. Y., Housing Corp., c/o Branleygram Co., 24 Journal Sq., plans the construction of an apartment building including steam heating system at Mallory, Roosevelt, Clendenny and Mauyan Sts. Estimated cost $1,000,000. Architect not announced.

N. J., Jersey City — Pennsylvania R.R. Co., Terminal Bldg., plans the construction of a 10 story office building on Exchange Pl. Estimated cost $1,000,000. T. J. Skillman, is chief engineer.

N. J., Lawrenceville—American Telephone & Telegraph Co., 15 Dey St., New York, N. Y., awarded contract for the construction of a trans-ocean transmitting station, here, to Morton C. Tuttle Co., 31 St. James Ave., Boston, Mass.

N. J., Newark—American Insurance Co., 70 Park Pl., is having plans prepared for a 10 story home office building including steam heating system, etc. Estimated cost $500,000. J. H. and W. C. Ely, 605 Broad St., are architects.

N. J., Newark—Bd. of Commissioners, City Hall, will soon award contract for the construction of a boiler room for airplane hangar at Newark Metropolitan Airport, Port Newark. Estimated cost $25,000. J. W. Costello, City Hall, is engineer.

N. J., Newark—Public Service Electric & Gas Co., 80 Park Pl., will build an electric sub-station at 1223-1229 Broad St., also plans an electric sub-station at Bloomfield Ave. and Erie R.R. Bloomfield. Estimated cost $60,000 and $40,000 respectively. Public Service Production Co., 80 Park Pl., is engineer. Work will be done by separate contracts.

N. J., Newark — T. L. Raymond, Dir. Dept. of Public Affairs, City Hall, will soon award contract for the construction of a boiler room, etc. for airplane hangar at Newark Metropolitan Airport.

N. J., Piscataawaytown—Public Service Electric & Gas Co., 180 Park Pl., Newark, will soon award contract for the construc-

tion of a meter and compressor house here. Estimated cost $40,000. Private plans.

N. J., Verona—Bd. of Chosen Freeholders, Hall of Records Bldg., Newark, awarded contract for the construction of a sanitarium and power house, here, to The Carlson Construction Co., Walnut St., Montclair. Estimated cost $1,000,000.

N. Y., New York—American Museum of Natural History, 77th St. and Columbus Ave., will receive bids in December for the construction of a power station and service building. Estimated cost $750,000. Trowbridge & Livingston, 527 5th Ave., are architects.

N. Y., New York—Y.M.C.A., awarded contract for the construction of a Y.M.C.A. building at 9th Ave. and 34th St. to E. Corning Co., 145 East 45th St. Estimated cost $1,000,000.

O., Cincinnati — Garber & Woodward, 4 West 7th St., Archts., will receive bids until Oct. 10, for a 15 story office building at 4th and Main Sts. for Union Gas & Electric Co., 4th St. Estimated cost $1,500,000.

O., Cleveland — Dept. of Public Welfare, J. E. Harper, Dir., Columbus, is having plans prepared for the construction of a cold storage plant, etc. on Turney Rd., here. Estimated cost $150,000. H. B. Briggs, Hartman Hotel Bldg., Cleveland, is state engineer.

O., Cleveland—University Hospitals of Cleveland, M. Potter, 10940 Euclid Ave., awarded contract for the construction of a hospital, nurses' dormitory, private pavillion, etc. at Euclid Ave. and Adelbert Rd. to John Gill & Sons, Bulkley Bldg. Total estimated cost $5,650,000.

Okla., Hobart—City will soon award contract for waterworks improvements including purification plant, motor driven centrifugal pump, etc. Estimated cost $46,000. Benham Engineering Co., Oklahoma City, is engineer.

Okla., Tulsa—Tulsa Athletic Club, c/o J. A. Reynolds, 221 East 16th St., is having plans prepared for a 12 story club, including steam heating system, etc. Estimated cost $1,000,000. Rush, Endicott & Rush, 404 Wright Bldg., are architects.

Pa., Ardmore — Syndicate, c/o A. H. Winters, 4 Lantern Lane, Philadelphia, awarded contract for the construction of a 6 story apartment building at Montgomery Pike, here. Estimated cost $1,000,000.

Pa., Philadelphia—C. E. Seigel, 419 South 46th St., will soon award contract for a 12 story apartment building at 47th and Pine Sts. Estimated cost $800,000. R. B. Bencker, 13th and Chestnut Sts., is architect.

Texas — Humble Pipe Line Co., Frost Bldg., San Antonio, is having plans prepared for the construction of a pumping station in connection with oil pipe line from Satsuma field to tank storage farm in Austin County. Estimated cost $75,000.

Tex., Dowling (mail Nederland) — Texarkana & Fort Smith Ry. Co., Texarkana, plans a $1,000,000 development program including transportation yard, power plant, etc., here. W. G. Morgan, is chief engineer.

Tex., Fort Worth—C. A. O'Keefe, 520 South Summit St., awarded contract for superstructure of a 23-story hotel at 5th and Main Sts. to Bellows-Maclay Construction Co. Construction Industries Bldg., Dallas. Estimated cost $1,000,000. Steam heating, ventilation systems, elevators, etc. will be installed.

Tex., Mineral Springs—E. L. Malsby, San Angelo and E. J. Roberts, Comanche, plan the construction of a 40 ton electrically operated ice plant here. Private plans.

Wash., Smith Island—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of a naval radio compass station, power house, etc. here to Bert Ward, 2512 Boylston Ave., North Seattle, Wash.

Wis., Milwaukee—E. Brielmaier & Sons Co., 425 East Water St., Archts., will receive bids until Oct. 15 for the construction of a hospital, nurses' home, etc. including steam heating and refrigeration systems, elevators, etc. at Chambers and Burleigh Ave. for St. Josephs Hospital of Franciscan Sisters, 439 4th St. Estimated cost $2,000,000.

B. C., Victoria—Victoria Cold Storage & Terminal Warehouse Co., awarded contract for the construction of a cold storage plant at Ogden Point to Tuney Bros., Ltd., Saywood Bldg. Estimated cost $400,000.

B. C., Vancouver—Miller, Court & Co., Ltd., 736 Graville St., awarded contract for a 10 story office building at Pender and Howe Sts., to Carter-Halls-Aldinger Co., Ltd., 500 Beatty St. Estimated cost $500,000. Steam heating system, etc., will be installed.

Ont., Hamilton—Royal Hotel & Terminal Co., 327 James St. S., is having plans prepared for a 14 story hotel, stores and bus terminal including steam heating system, etc. on James St. N. Estimated cost $3,000,000. F. G. Engelholm, 321 Bloor Bldg., Toronto, is architect.

Equipment Wanted

Boiler—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Oct. 31 for boiler and accessories for Naval Operating Base (Air Station) San Diego, Calif.

Boiler, Pump, Motor Engine, Air Compressor, etc. — A. L. Flint, General Purchasing Officer of the Panama Canal, Washington, D. C., will receive bids until Oct. 17, for boiler, pump, motor, gasoline engine, air compressor, switches, switchboard, circuit breakers, etc.

Boilers, Engines, Pumps, etc. — Fir-Tex Insulating Co., A. E. and C. A. Millington, Ind. Engrs., Portland, Ore., is in the market for 3,000 hp. boilers, three 500 hp. engines, pumps, etc. for proposed paper board mill at St. Helens, Ore. Estimated cost $2,000,000.

Boilers, Pumps, Breeching, etc. — Bd. of Public Service, L. Day, Comr., 208 City Hall, St. Louis, Mo., will receive bids until Oct. 30, for furnishing and installing boilers, pumps, breeching, air preheaters, etc. at Howard's Bend Waterworks station on Missouri River. Estimated cost $55,000.

Boilers, Stokers, Etc. — Dept. of Public Works, Milwaukee, Wis., will receive bids until Oct. 15 for moving and resetting two 400 hp. horizontal water tube boilers with mechanical stokers, soot blowers, etc. at boiler room of North Point pumping station.

Coal Handling Equipment—Steel & Tubes Co., 232 East 131st St., Cleveland, O., plans to purchase coal handling equipment, etc. for proposed power plant and outdoor sub-station at Ferndale, Mich.

Electrical Equipment—Dept. of Mental Hygiene, Albany, N. Y., will receive bids until Oct. 10, for equipment for two double end steel Diesel electric ferryboats for Manhattan State Hospital, Ward's Island, New York, N. Y.

Generators, etc. — Quartermaster Dept., U. S. Army, Washington, D. C., will receive bids until Oct. 18, for four generators, exciters, regulators, switchboard, etc.

Pump and Motor — Westchester County Park Commission, 72 West Pondfield Rd., Bronxville, N. Y., will receive bids until Oct. 17 for a centrifugal pump and motor, etc. for a recirculating, filtering and sterilizing equipment plant at Rye Beach Amusement Park, Rye, N. Y.

Pumping Equipment — H. G. Bell, City Secy., Archer City, Tex., will receive bids until Oct. 23, for pumping equipment, etc. for proposed waterworks improvements.

Pumping Unit — Bd. of Water Commissioners, F. P. Book, Pres., Detroit, Mich., will receive bids until Oct. 17 for a 10,000 g.p.m. electric motor driven centrifugal pumping unit with auxiliary equipment for booster station at 2600 Fenkell Ave., Detroit, Mich.

Pumping Unit — City of Liberty, Tex., pumping unit, etc. for proposed waterworks and distribution systems. Estimated cost $50,000.

Pumps — Bd. of Commissioners, Indianapolis, Ind., will receive bids until Oct. 15, for two horizontal double acting boiler feed pumps for Marion County Tuberculosis Hospital.

Pumps, etc. — City of Hamilton, Ont., plans the installation of pumps, etc. for proposed sewage disposal plant at Lotteridge Inlet. Estimated cost $195,000.

Refrigeration Equipment — Bureau of Yards & Docks, Navy Dept., Washington, D. C., refrigeration equipment for Naval Operating Base, supply Depot, San Diego, Calif.

Refrigeration Equipment — Victoria Cold Storage & Terminal Warehouse Co., Victoria, B. C., plans to purchase refrigeration equipment to cost $150,000 for proposed cold storage plant.

Industrial Projects

Calif., Colton—MATERIAL and SUPPLY FACTORY—J. H. Miller, California Hotel Bldg., San Bernardino, is having plans prepared for the construction of a factory on 8th St., here. Eldridge & Renfro, California Hotel Bldg., San Bernardino, are architects. Colton Building Material & Supply Co., and Colton Furniture Co., Colton, are lessees.

Conn., Hartford—BRASS FOUNDRY—M. S. Little Mfg. Co., 151 New Park Ave., awarded contract for a 1 story, 50 x 120 ft. brass foundry to Bartlett-Brainard Co., 252 Asylum St. Estimated cost $40,000.

Ind., Indianapolis—CARBURETOR FACTORY—Wheeler-Schebler Co., 1302 Barth Ave., is receiving bids for the construction of a factory. Estimated cost $50,000. D. A. Bohlen & Son, 1001 Majestic Bldg., are architects.

Ind., South Bend—ENGINE FACTORY—Dodge Mfg. Co., manufacturers of oil engines, awarded steel contract for a 1 story, 99 x 200 ft. factory on South Union St. Estimated cost $46,000.

Ind., South Bend — LUMBER MILL — Indiana Lumber Mfg. Co., awarded contract for a 2 story, 34 x 160 ft. mill at 742 South Michigan St. to C. A. Jordan, 725 Wilbur St. Estimated cost $47,000.

Mass., Lynn—SHOE FACTORY—Bender Shoe Co., M. F. Costigan, is receiving bids for a 1 and 2 story factory including heating plant at 95 State St. Sanborn & Weed, Item Bldg., are architects.

Mich., Detroit — BODY PLANT — Fisher Body Corp., General Motors Bldg., awarded contract for 1 and 2 story, 100 x 800 and 40 x 100 ft. factory and office including power plant on French Rd. to J. A. Utley Co., 729 Penobscot Bldg.

Mich., Ferndale (br. Detroit) — SHEET METAL and TUBE FACTORY — Steel Tubes, Inc., W. J. Sampson, Jr., Pres., 224 East 131st St., Cleveland, O., awarded contract for a 1 story, 210 x 500 ft. factory here to Cooper-Little Co., 4612 Woodward Ave., Detroit, Mich. Estimated cost $400,000.

Mich., Flint—SPARK PLUG FACTORY—A. C. Spark Plug Co., Harriet St. and Industrial Ave., had plans prepared for a 1 story, 144 x 275 ft. factory on Industrial Ave. Estimated cost $150,000. Private plans. Ovens for heat treat process will be required.

Mich., Flint—MACHINE SHOP—Chevrolet Motors Co., General Motors Bldg., Detroit, had plans prepared for a 1 story, 205 x 315 ft. machine shop on West Kearsley St., here. Wright & Nice, 4339 South Saginaw St., Flint, are architects. Equipment will be required.

Mich., Grand Rapids—STORE EQUIPMENT FACTORY—Grand Rapids Store Equipment Co., Monroe Ave. N. W., awarded contract for a 100 x 166 and 40 x 100 ft. factory on Monroe St. to Owen-Ames-Kimball, Pearl St. Estimated cost $50,000.

Mich., Kalamazoo—LOOSE LEAF BINDER FACTORY—Kalamazoo Loose Leaf Binder & Equipment Co., West Kalamazoo Ave., awarded contract for a 1 story, 100 x 300 ft. factory to O. F. Miller Construction Co., 224 Pratt Bldg. Estimated cost $75,000.

O., Cleveland — GEAR AND FORGING FACTORY—Gears & Forgings Inc., 3010 Woodhill Rd., had plans prepared for a 3 story, 72 x 72 ft. addition to factory. Estimated cost $50,000. Carter-Richards Co., 622 Engineers Bldg., is architect and engineer.

O., Alliance — FORGING FACTORY — Transue & Williams Steel Forgings Corp., awarded contract for a 1 and 2 story addition to factory to H. K. Ferguson Co., Hanna Bldg., Cleveland. Estimated cost $100,000.

Pa., Philadelphia — STEEL and IRON PLANT — Morris Wheeler Co., 20th and Locust Sts., plans the construction of a manufacturing plant, office and power plant at Fox St. and Roberts Ave. Estimated cost $1,500,000. J. S. Simsohn, Broad and Girard Sts., is engineer.

Tex., Waco — CEMENT PLANT—Atlas Portland Cement Co., 25 Broadway, New York, N. Y., plans the construction of a cement plant, 1,000,000 bbl. annual capacity here. Estimated cost $2,000,000. Work will be done under the supervision of company engineers.

Ont., Peterborough — PUNCH PRESS BUILDING—Canadian General Electric Co., Park St., plans the construction of a 1 story, 110 x 328 ft. Estimated cost $100,000. Private plans.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

FIRMNESS continues to characterize the market for power-plant and electrical supplies, although this condition is not so marked as in September. Belt lacings are higher than a month ago, while larger discounts may be obtained on medium grade, heavy weight leather belting at New York warehouses. Linseed oil is up 0.3c. to 10.8c. per lb. at New York and Chicago. Genuine, highest grade babbitt metal declined ¼c. per lb. from the September level. Electrical supplies remain steady at last month's quotations in buying centers east of the Mississippi.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply ... $0.30	4 ply ... $0.36	

Steam—Discounts from List

First grade ... 40%	Second grade ... 45%	Third grade ... 50–10%	

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	60%

LEATHER BELTING—List price, 24c., per lin.ft. per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium grade	30–10%
Medium grade, heavy weight	30@5%

RAWHIDE LACING—For cut, best grade, 30@5%; 2nd grade, 45@5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c. Semi-tanned, cut, 30–5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ½ in.	$0.90
Asbestos for high-pressure steam, ½ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25@$2.35 per bbl. without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in thick and heavier; all $3.30 per 100 lb. in lots of 250 to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00
Colored	9.00@13.00	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.17
New York	.15½
Cleveland (*per thousand*)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.108	$0.105	$0.108

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, small, including ⅞-in. dia., list (Apr. 1, 1927) less 50-10% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ¾-in., per 100 lb.:
New York ..... $5.00* Chicago ... $3.60 Pittsburgh mill $2.90

Cone-head boiler rivets, ½-in., per 100 lb.:
New York ..... $5.30* Chicago ... $3.90 Pittsburgh mill $3.20

*Price is for full packages; broken package lots, $6.50 net, delivered.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	67.75
Commercial genuine, intermediate grade	53.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.25

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.60
Flat or square	3.90	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2¼ and 2½ in..... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid.....	$31.00 (net)	$45.00 (net)	$180.00	$220.00
No. 12 solid.....	136.00	180.00	225.00	275.00
No. 10 solid.....	185.00	235.00	275.00	325.00
No. 8 stranded..	305.00	375.00	420.00	500.00
No. 6 stranded..	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots.....	50%	30%
Coils to 1,000 ft.....	60%	35%
1,000 to 5,000 ft.....	65%	38%
5,000 ft. and over.....	67%	40%

CONDUIT—Price per 1,000 ft.: **ELBOWS AND COUPLINGS**, per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. Delivery charges, approximately 4 per cent. additional.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
¾	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package.....	10%	20%	28%
Less than standard package.....	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.....	$0.12	D. P. D. B.....	$0.31
D. P. M. L.....	.16	T. P. S. B.....	.35
T. P. M. L.....	.27	T. P. D. B.....	.47
D. P. S. B.....	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.....	$0.27	$0.70	$1.75
T. P. M. L.....	.40	1.00	2.30
D. P. S. B.....	.35	.87	.....
T. P. S. B.....	.67	1.50	.....
D. P. D. B.....	.65	1.75	.....
T. P. D. B.....	1.12	3.00	.....
T. P. to D. P. D. B.....	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy.....		$16.50
No. 16 cotton reinforced heavy.....		20.00
No. 18 cotton reinforced light.....		13.00
No. 16 cotton reinforced light.....		17.60
No. 18 cotton Canvasite cord.....		14.60
No. 16 cotton Canvasite cord.....		16.90
No. 16 super service cord or similar (2 wire) in 1,000 ft....	$72.00	*80.00
No. 14 super service cord or similar (2 wire) in 1,000 ft....	110.00	*122.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons.....	Net
Unbroken cartons.....	22%
Ten unbroken cartons.....	40%
Discount Without Contract—Renewals:	
Broken cartons.....	Net list
Unbroken cartons.....	22%
Ten unbroken cartons.....	40%
Discount With Contract—Fuses:	
Broken cartons.....	10%
Unbroken cartons.....	26%
Ten unbroken cartons.....	42%
Discount With Contract—Renewals:	
Broken cartons.....	Net list
Ten unbroken cartons.....	42%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500).....	$2.50
0-30 ampere, less than standard package.....	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.22	....	....	....
60	A 21	.22	....	....	....
100	A 23	.35	....	....	....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug.....	$0.18
Composition, 2-piece, attachment plug.....	.27
Swivel attachment plug.....	.12
Small size, 2-piece plug, composition.....	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.75	$8.00	$9.75	$16.00
12	8.80	10.20	12.10	22.00
10	11.90	14.00	16.00	28.90
8	17.50	19.20	20.15	39.50
6	.....	.....	30.00	.....
4	.....	.....	42.00	.....
2	.....	.....	60.00	.....
1	.....	.....	82.00	.....
0	.....	.....	101.00	.....
00	.....	.....	119.00	.....
000	.....	.....	142.00	.....
0000	.....	.....	172.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package.	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton..	.14	.12	.18	.18	.16	.21
Broken carton....	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.		100 lb. lots....	29c. per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb..		100 lb. lots....	31c per lb.
Wire solder, less than 100 lb., 33c. per lb.....		100 lb. lots....	31c. per lb.
Soldering paste, 2 oz. cans.....			$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value.....	30%
$25.00 to $50.00 list value.....	30-5%
$50.00 list value or over.....	35%